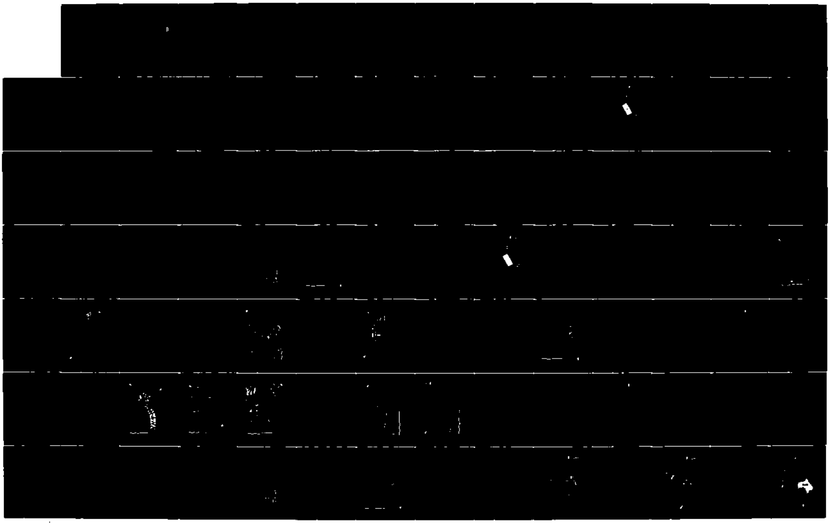
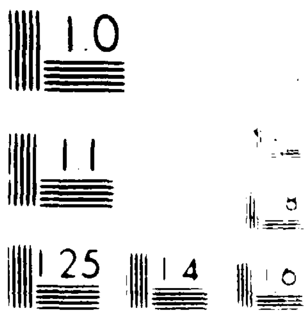
AD-A184 842 INSTALLATION RESTORATION PROGRAM PHASE 2 CONFIRMATION/QUANTIFICATION STAG..(U) WESTON (ROY F) INC WEST CHESTER PA R L KRAYBILL ET AL. AUG 87 1/4

UNCLASSIFIED F33615-84-D-4400 F/G 24/4 NL




1.0
1.1
1.25
1.4

AD-A184 842

INSTALLATION RESTORATION PROGRAM
PHASE II - CONFIRMATION/QUANTIFICATION
STAGE 1

VOLUME I

PEASE AIR FORCE BASE
NEW HAMPSHIRE

DTIC
ELECTE
SEP 0 2 1987
S D
D

Roy F. Weston, Inc.
West Chester, Pennsylvania 19380

AUGUST 1987

FINAL REPORT FOR PERIOD OCTOBER 1984 TO JULY 1986

Approved for Public Release. Distribution is Unlimited

PREPARED FOR

HEADQUARTERS STRATEGIC AIR COMMAND
COMMAND SURGEON'S OFFICE HEADQUARTERS (HQSAC/SGPB)
BIOENVIRONMENTAL ENGINEERING DIVISION
OFFUTT AIR FORCE BASE, NE 68113

UNITED STATES AIR FORCE
OCCUPATIONAL & ENVIRONMENTAL HEALTH LABORATORY (USAF OEHL)
TECHNICAL SERVICES DIVISION (TS)
BROOKS AIR FORCE BASE, TEXAS 78235-5501

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

AD-A184842

REPORT DOCUMENTATION PAGE

1a REPORT SECURITY CLASSIFICATION Unclassified	1b RESTRICTIVE MARKINGS None
2a SECURITY CLASSIFICATION AUTHORITY N/A	3 DISTRIBUTION/AVAILABILITY OF REPORT Approved for Public Release, Distribution Unlimited
2b DECLASSIFICATION/DOWNGRADING SCHEDULE N/A	
4 PERFORMING ORGANIZATION REPORT NUMBER(S) N/A	5 MONITORING ORGANIZATION REPORT NUMBER(S) N/A
6a NAME OF PERFORMING ORGANIZATION Roy F. Weston, Inc. — 6b OFFICE SYMBOL (If applicable)	7a NAME OF MONITORING ORGANIZATION USAFOEHL/TSS
6c ADDRESS (City, State, and ZIP Code) One Weston Way West Chester, PA 19380	7b ADDRESS (City, State, and ZIP Code) Brooks AFB, TX 78235-5501
8a NAME OF FUNDING/SPONSORING ORGANIZATION USAFOEHL/TSS — 8b OFFICE SYMBOL (If applicable)	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER F33615-84-D-4400
8c ADDRESS (City, State, and ZIP Code) Brooks AFB, TX 78235-5501	10 SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO / PROJECT NO / TASK NO / WORK UNIT ACCESSION NO

11 TITLE (Include Security Classification) IRP, Phase II Confirmation, Quantification, Stage 1 Report for Pease AFB, New Hampshire

12 PERSONAL AUTHOR(S)
Richard L. Kraybill, Glenn R. Smart, Alison L. Dunn, Gerald T. O'Neill

13a TYPE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (Year, Month, Day)	15 PAGE COUNT
Technical Draft	FROM 84-10 TO 86-8	August, 1987	

16 SUPPLEMENTARY NOTATION

17 COSATI CODES			18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	IRP, Pease AFB, Phase II, Stage 1, Contamination, priority pollutant, groundwater

19 ABSTRACT (Continue on reverse if necessary and identify by block number)

An Installation Restoration Program (IRP), Phase II Stage 1 Confirmation/Quantification Study was performed at Pease AFB between October 1984 and January 1986. A total of 20 sites were investigated in the Phase II Stage 1 Study. For purposes of site investigation, 15 of the sites were grouped into six investigation "zones"; four were considered separately. A fifth site (Site 22) suspected to be a former fire training area, was discovered during the initial stages of the Phase II investigation. A preliminary analysis of this additional site is included with adjacent Site 10. Information regarding potential or actual impacts of the 20 sites on area groundwater and surface water was obtained from 35 monitoring wells, 31 test pits, 31 power (continued)

20 DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21 ABSTRACT SECURITY CLASSIFICATION Unclassified
22a NAME OF RESPONSIBLE INDIVIDUAL Edward S. Barnes, Lt Col, USAF	22b TELEPHONE (Include Area Code) (512) 536-2158 — 22c OFFICE SYMBOL TS

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

Abstract (cont'd)

auger borings, 29 surface water sampling locations, six sediment sampling locations, six production wells, two abandoned storage tanks, a geophysical field investigation, and a field survey of locations, top of casing elevations, and water levels at all monitoring wells. Two rounds of groundwater and surface water samples, were collected. Analytes included the screening parameters TOX, TOC, Oil & grease, phenols, cyanide, and selected Priority Pollutant organics and metals at certain sites.

Hydrogeological data developed in this investigation indicate that Pease AFB is predominantly underlain by glacial deposits and marine clays having a wide range of water-bearing potential. These deposits are underlain by metasedimentary bedrock which was observed to be moderately to highly fractured in the upper zones investigated in this Stage 1 study. The permeable kame plain deposits and the upper fractured zones of bedrock were concluded to be the two principal receptors and migration pathways at sites where contamination was found.

Although the screening parameters of TOX, TOC, and O&G did not provide compound-specific information, they were useful in categorizing sites which had been suspect spill or disposal sites for fuels or solvents. Where compound-specific data were collected, no priority pollutant volatile organic compounds which exceeded a State or Federal Maximum Contaminant Level (MCL) were found in the newly installed monitoring wells or surface water sampling locations. A base production well (Haven Well) sampled during the Phase II Stage 1 investigation has shown contamination in excess of the proposed MCL for trichloroethylene. In addition, phenols and selected metals were found to exceed MCLs at localized groundwater or surface water sampling locations.

Overall base water quality was concluded to be generally good with respect to State and Federal Standards. However, due to some evidence of localized contamination, thirteen of the twenty study sites were recommended for further study. Many of these sites require additional sampling for specific priority pollutant compounds to confirm that they do not, indeed, pose a significant environmental concern. Of the thirteen sites recommended for further investigation, six sites were recommended for a quantification effort requiring the installation of supplemental wells. Of the six sites, two sites (FDTA-2 and LF-6) warrant full scale quantification stage efforts.

Two sites (IS/PA and LFTS) were recommended for "expedited remedial actions" involving former storage tanks and buried drum removal. A prediction of the nature and extent of off-site impacts, if any, arising from past disposal practices at the sites studied could not be made based upon the Stage 1 investigation.

INSTALLATION RESTORATION PROGRAM

PHASE II - CONFIRMATION/QUANTIFICATION

STAGE 1

Volume I

Final Report

For

Pease Air Force Base,
New Hampshire

Headquarters Strategic Air Command

Offutt Air Force Base, Nebraska

August 1987

Prepared By

Roy F. Weston, Inc.
Weston Way
West Chester, Pennsylvania 19380

USAF Contract No. F33615-84-D-4400, Delivery Order 0005
Contractor Contract No. F33615-84-D-4400
Delivery Order No. 5

USAFOEHL TECHNICAL PROGRAM MANAGER
LTC Edward S. Barnes

USAF OCCUPATIONAL ENVIRONMENTAL HEALTH LABORATORY (USAFOEHL)
BROOKS AIR FORCE BASE, TEXAS 78235-5501

WESTON

NOTICE

This report has been prepared for the United States Air Force by Roy F. Weston, Inc. for the purpose of aiding in the implementation of the Air Force Installation Restoration Program. It is not an endorsement of any product. The views expressed herein are those of the contractor and do not necessarily reflect the official views of the publishing agency, the United States Air Force, nor the Department of Defense.

Copies of this report may be purchased from:

National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161

Federal Government agencies and their contractors registered with the Defense Technical Information Center should direct requests for copies of this report to:

Defense Technical Information Center
Cameron Station
Alexandria, Virginia 22314

A-1

WESTON

PREFACE

Roy F. Weston, Inc. (WESTON) has been retained by the United States Air Force Occupational and Environmental Health Laboratory (USAFOEHL) under Contract No. F33615-84-D-4400 to provide general engineering, hydrogeological, and analytical services. These services were applied to a hydrogeologic investigation of former waste disposal sites and areas where hazardous substances may have been used.

This work was accomplished between October 1984 and December 1985. Lt Col Edward S. Barnes, Technical Services Branch, USAFOEHL, was the principal point of contact during the project. The program was managed through the WESTON home office in West Chester, Pennsylvania. Execution of the project was managed through WESTON's Concord, New Hampshire Regional Office. Peter J. Marks was the Program Manager, and Frederick Bopp III, Ph.D., P.G. was the Contract Manager. In April 1985, Katherine A. Sheedy, P.G. became the Contract Manager. Richard L. Kraybill, P.G. was the Project Manager, and Glenn R. Smart was the Technical Team Leader for this project.

WESTON wishes to acknowledge the help of Pease AFB, particularly the Bioenvironmental Engineering and Civil Engineering offices, for assistance in all phases of the field work.

TABLE OF CONTENTS

WESTON

TABLE OF CONTENTS (continued)

WESTON

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

WESTON

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

WESTON

TABLE OF CONTENTS (continued)

WESTON

TABLE OF CONTENTS (continued)

WESTON

LIST OF FIGURES

WESTON

LIST OF FIGURES (Continued)

WESTON

LIST OF FIGURES (Continued)

WESTON

LIST OF TABLES

WESTON

LIST OF TABLES (Continued)

WESTON

LIST OF TABLES (Continued)

EXECUTIVE SUMMARY

PROGRAM HISTORY AT PEASE AIR FORCE BASE

Roy F. Weston, Inc. (WESTON) had been retained by tne United States Air Force Occupational and Environmental Health Laboratory (USAFOEHL) under Basic Ordering Agreement (BOA) Contract Number F33615-80-D-4006 to provide the Air Force with general engineering, analytical, and hydrogeological services. The Phase I Problem Identification/Records Search for Pease AFB was accomplished by CH2M Hill in late 1983, and their Final Report was dated January 1984. In the response to the findings contained in the Phase I Final Report, USAFOEHL issued Task Order 0039 to WESTON directing that a presurvey be conducted at Pease AFB. The purpose of this presurvey was to obtain sufficient information to develop a work scope and cost estimate for the conduct of a Phase II Stage 1 Problem Confirmation Study at Pease AFB.

Based upon the conclusions of the Phase I Records Search, the Phase II Presurvey Report, and the overall HARM score ratings, sixteen sites at Pease AFB were recommended for Phase II Stage 1 Confirmation Study Investigations. Two sites listed in the Phase I Report (Site 16: PCB spill site, and Site 18: Munitions Residue Burial Site) were not recommended for further study. Three additional sites (Sites 19, 20, 21: Newfields Ditch, Grafton Ditch, and McIntyre Brook) were added to the list of sites requiring further study bringing the total to nineteen sites. An additional suspected fire training area was identified from aerial photographs prior to the startup of Stage 1 field activities. This new site was named Site 22 and brings to twenty the number of sites investigated during the Phase II Stage 1 study. All Phase I and II Study Sites are illustrated in Figure S-1.

A pre-performance meeting, including representatives of WESTON, USAFOEHL, Pease AFB, and the drilling subcontractor, ConTec., Inc., was held on 17-18 October 1984 to review the goals of the investigation, to review drilling procedures and locations, and to establish the field schedule. Field work began on 25 October 1984 and was completed on 27 January 1986. Methods, findings, and recommendations for

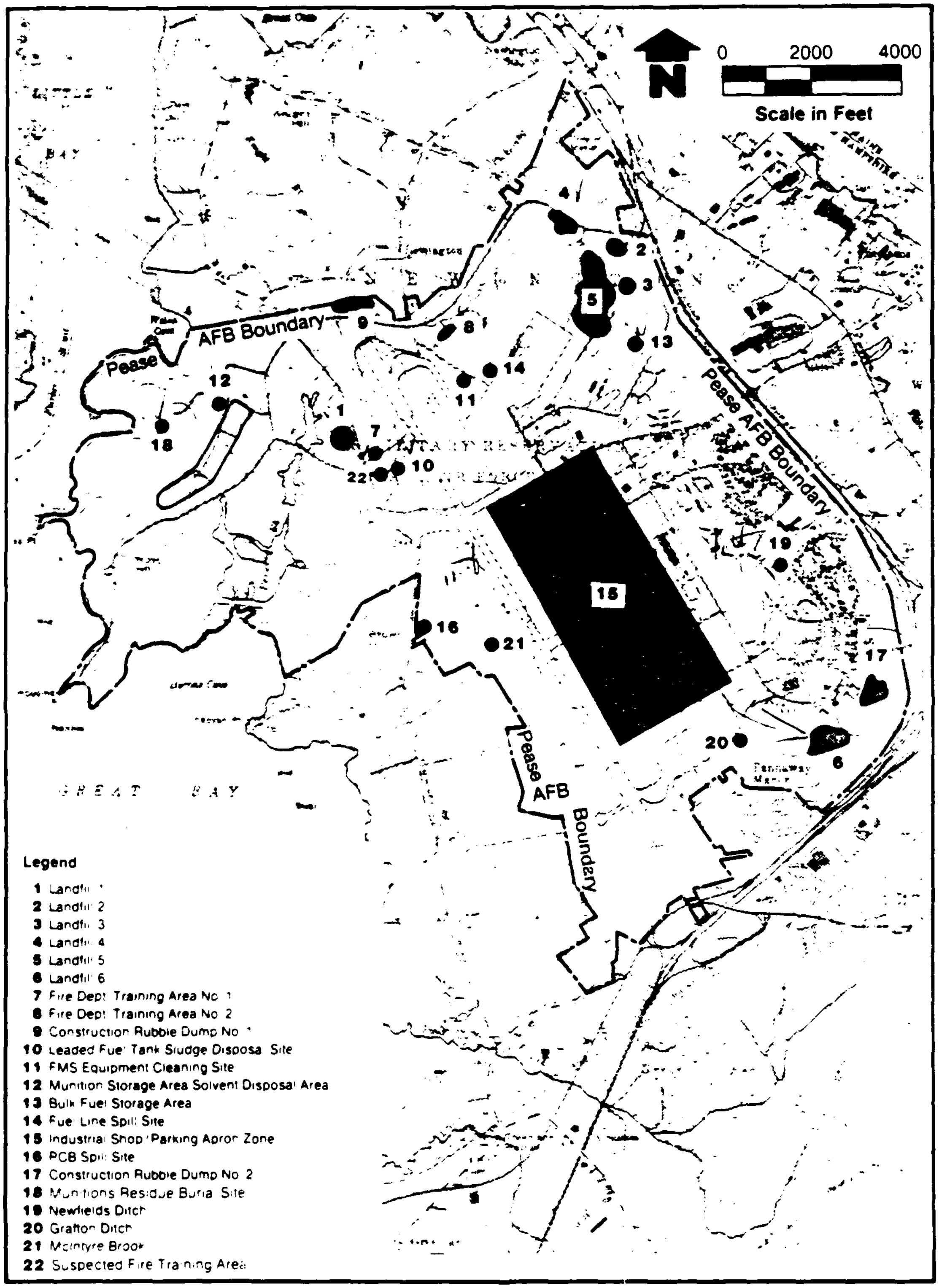


FIGURE S-1 LOCATION MAP OF IDENTIFIED SPILL AND WASTE DISPOSAL SITES AT PEASE AFB

additional work based on the results of this investigation are summarized in this report.

Sites that were similar in nature or in close proximity to one another were grouped together in zones. A total of ten areas were investigated. Table S-1 presents the organization of the sites into individual sites and zones.

INVESTIGATION OBJECTIVES AND METHODS

The objectives of the field investigation were: (1) to confirm the presence or absence of environmental contamination within specified sites or zones of investigation; (2) if contamination exists, to determine the potential for contaminant migration in the various environmental media; (3) to identify additional investigations necessary to determine the magnitude, extent, direction, and rate of contaminant migration; and (4) identify potential environmental consequences and health risks of migrating pollutants. Information regarding potential or actual impacts of the 20 sites on area groundwater and surface water was obtained from 35 monitoring wells, 31 test pits, 31 power auger borings, 29 surface water sampling locations, six sediment sampling locations, six production wells, two abandoned storage tanks, a geophysical survey, a topographic survey of locations, top of casing elevations and water levels at all monitoring wells, a review of all available aerial photographs, a literature search of local hydrogeologic conditions, and compilation of a local well inventory. Two rounds of surface water and groundwater monitoring and a single round of soil and sediment monitoring were performed in accordance with the approved analytical protocols (Table S-2).

MAJOR FINDINGS

Principal Hydrogeologic Conclusions

The following are conclusions regarding the hydrogeologic setting at Pease AFB:

- Pease AFB is underlain by several unconsolidated formations of glacial origin. These are chiefly grouped in order of depositional sequence as: 1) glacial till, 2) marine clays, and 3) kame plain deposits.

WESTON

Table S-1

SUMMARY OF PHASE II INVESTIGATION SITES

Zone No.	Site No.	Site Description	Abbreviated Designation
--	8	Fire Dept. Training Area No. 2	FDTA 2
1	13	Bulk Fuel Storage Area Spills	BFSA
	2	Landfill No. 2	LF-2
	3	Landfill No. 3	LF-3
	4	Landfill No. 4	LF-4
	5	Landfill No. 5	LF-5
2	7	Fire Dept. Training Area No. 1	FDTA 1
	1	Landfill No. 1	LF-1
3	15	Industrial Shop/ Parking Apron	IS/PA
4	19	Newfields Ditch	
	20	Grafton Ditch	
	21	McIntyre Brook	
		Base Production Wells	
--	12	Munitions Storage Area Solvent Disposal Area	MSA
--	9	Construction Rubble Dump No. 1	CRD 1
5	6	Landfill No 6	LF-6
	17	Construction Rubble Dump No. 2	CRD 2
--	10	Leaded Fuel Tank Sludge Disposal Site	LFTS
6	11	FMS Equipment Cleaning Site	FMS
	14	Fuel Line Spill Site	FLS
--	22	Suspected Fire Training Area	Site 22

-- = Considered individually, no zone number

TABLE S-2

ANALYTICAL PROTOCOL FOR PHASE II, STAGE I SITES

Zone	Site	Sample Type and Number (1)	Analytes
--	8	6 soil	TOX, O&G
		13 groundwater	TOX, TOC, O&G
1	13	9 groundwater	TOX, TOC, O&G
		2 surface water	TOX, TOC, O&G
1	Sites 2,3,4,&5	11 groundwater	TOX, TOC, O&G, CN, pesticides, phenols, metals
		15 surface water	TOX, TOC, O&G, CN, pesticides, phenols, metals
2	7	3 soil	TOX, O&G
		2 groundwater	TOX, TOC, O&G
2	1	6 groundwater	TOX, TOC, O&G, CN, pesticides, phenols, metals
		9 surface water	TOX, TOC, O&G, CN, pesticides, phenols, metal
3	15	17 soil	TOX, O&G, phenols, metal, VOC
		16 groundwater	TOX, TOC, O&G, phenols, metal, VOC
		2 tank	TOX, TOC, O&G, VOC
4	Sites 19,20,21	7 sediment	TOX, O&G, metals
		13 surface water	TOX, TOC, O&G, metals
4	Production Wells	13 groundwater	TOX TOC, O&G, metals, VOC
--	12	3 sediment	TOX, O&G
		4 surface water	TOX, TOC, O&G
		2 groundwater (abandoned production wells)	TOX, TOC, O&G
--	9	7 surface water	TOX, O&G
		5 groundwater	TOX, O&G
5	Sites 6 & 17	8 groundwater	TOX,TOC, O&G, phenols, metals
		13 surface water	TOX, TOC, O&G, phenols, metals
--	10	6 soil	O&G, lead
		7 groundwater	O&G, lead
6	11	4 soil	TOX, O&G
		2 groundwater	TOX, TOC, O&G
6	14	3 soil	O&G
		3 groundwater	O&G

(1) Includes QA/QC Samples

— Considered individually

TOX - Total Organic Halogens
O&G - Oil and Grease
TOC - Total Organic Carbon
VOC - Volatile Organic Compounds

Each of these formations has unique lithologic properties which affect the potential for contaminant migration from prior disposal sites or areas where hazardous substances were formerly used. The unconsolidated deposits overlie bedrock of metasedimentary origin. The bedrock underlying Pease AFB also exhibits unique hydrogeologic properties which affect the interpretation of former site use.

- o Groundwater occurs within all geologic formations on Pease AFB. Within the unconsolidated permeable deposits, groundwater occurs principally under unconfined or water table conditions. Groundwater flow within the unconsolidated deposits underlying approximately two-thirds of the base is to the south under a gradient of approximately 0.01.

The migration of water quality constituents within a groundwater flow system is based, in part, on the lithologic properties of the primary geologic strata underlying a given site. Groundwater flow velocities, which were computed from the values of hydraulic conductivity, effective porosity estimates, and calculated hydraulic gradients at each site, provide insight into the potential for contaminants migration from a given site. In general, the sites underlain by saturated kame plain deposits, such as the FDTA-1, FDTA-2, FMS, FLS, and portions of IS/FA, possess the highest potential for migration of water quality constituents attributable to past practices since seepage velocities and total flow from those sites are concluded to be comparatively high.

Soil and Water Quality

The following principal conclusions are drawn from the analytical data collected during the Phase II investigation:

- o The screening protocols of TOX, TOC, and O&G used during the Phase II Stage 1 Study do not provide compound-specific data to identify the presence and types of priority pollutant compounds suspected at the identified sites. The screening protocols, in combination with field tests or compound-specific analyses for priority pollutants,

WESTON

did provide sufficient information to cate-gorize the sites. Specific analysis for priority pollutant compounds or hazardous waste constituents are essential for Stage 2 site investigations.

- Iron was commonly present in surface and groundwaters at Pease AFB. Iron was detected in excess of the 0.3 mg/L New Hampshire Drinking Water Standard in 17 groundwater monitoring well samples. The standard is based on aesthetic values. The concentrations detected in groundwaters and surface waters was concluded to represent natural conditions except where other apparent indicators of contamination were present.

  Other metals detected in excess of State Drinking Water Standards in groundwater were arsenic, cadmium, and lead. Arsenic was detected in three wells and cadmium and lead each were detected in one well slightly in excess of State Drinking Water Standards. These results were observed in only one of two rounds of samples.

  Arsenic (3 locations), cadmium (1 location), and lead (4 locations) were detected in excess of State Drinking Water Standards in surface waters. Only lead was detected above State Drinking Water Standards in more than one round of sampling (1 location). Based on the above results, the presence of metals in surface and groundwaters was not generally found to indicate impacts attributable to past waste disposal and handling practices.

- Phenols were detected in 13 monitoring well samples, 11 surface water samples, and two field blanks at levels in excess of New Hampshire's Drinking Water Standard of 0.001 mg/L. This aesthetic standard is set to protect consumers from taste and odors in chlorinated supplies. None of the samples exceeded the 3.5 mg/L toxic level established by the USEPA Water Quality Criteria Documents. It is, therefore, concluded that the phenols detected do not present a health hazard.

WESTON

- No priority pollutant volatile organic compounds were detected in excess of State MCLs in any water sample. Trichloroethylene was found on two occasions in the Haven Well at levels of 3.5 and 7.2 ug/L. These levels are below the New Hampshire MCL of 75 ug/L. The proposed USEPA MCL of 5 ug/L was exceeded in the Haven Well on one occasion. The declining trend in TCE concentrations in the Haven Well from a high of 391 ug/L to the current levels of 3.5 to 7.2 ug/L indicates that the contamination problem at this well has probably been mitigated by natural processes or by cessation of the contributing source(s).

- A DDT isomer was found in samples from SW-7 and SW-16 in levels that exceed Federal guidance criteria (USEPA Water Quality Criteria Documents). No Federal or State pesticide or herbicide regulatory limits were exceeded in any groundwater or surface water.

Site-Specific Conclusions

As a conclusion to the investigation, each of the sites investigated can be categorized according to whether it requires no further action (Category I), requires further investigation (Category II), or is ready for remedial action (Category III). Sites may be subsequently recategorized at the end of each successive stage of the Phase II investigation until all are ready for remedial action (Phase IV of the IRP investigation) or no action. The following definitions have been used in the classification of investigation sites at Pease AFB:

- Category I applies to sites where no further action (including remedial action) is required.

- Category II applies to sites requiring additional investigation to quantify or further assess the extent of current or future contamination.

- Category III applies to sites where remedial action is required and all necessary data to support an analysis of remedial alternatives have been gathered. These sites are considered ready for IRP Phase IV action.

Site-by-site conclusions are summarized in Table S-3 which lists a category for each site, presents the rationale for that categorization, and references the report subsections that present supporting evidence for that categorization.

ALTERNATIVE ANALYSIS

Based on the results of the categorization, thirteen sites fell into Category II, thus requiring further investigation.

Eight investigative alternatives are potentially applicable for consideration at Pease AFB. These are: 1) additional sampling at existing monitoring points, 2) expansion of the current monitoring network, 3) aerial photo analysis, 4) analyses of receptors, 5) non-destructive testing, 6) soil-gas testing, 7) groundwater modeling, and 8) other studies such as aquatic biological investigations.

For each Category II site, an assessment was made of each available investigative alternative and its applicability to the given site. Based upon the alternative analysis, specific recommendations were formulated to match the needs of each Category II site.

RECOMMENDATIONS

General Recommendations

The TOX, TOC, and O&G analyses have been used as a screening methodology to indicate the presence of organic compounds in soil or water. The Stage 2 sampling protocols should be compound-specific for the parameters of concern. The recommended analytical protocols may change subject to review of the Stage 1 Report and the evaluation of priorities. The multi-level well installations recommended may also function to assess overall base-wide water quality with respect to hazardous waste constituents.

Site-Specific Recommendations

Site-specific recommendations for further field investigations at 13 sites are summarized in Table S-4. Additional wells should be constructed of the same materials as were used in the Stage 1 monitoring wells. The analytical protocols are based on the Phases I and II Stage 1 findings.

Site-Specific Remedial Investigations

The abandoned waste TCE tank at Building 244 within IS/PA, and the buried drums at LFTS are recommended for "expedited remedial action".

Table S-3

SUMMARY OF SITE-SPECIFIC CONCLUSIONS
PEASE AFB, PHASE II STAGE 1 IRP INVESTIGATION

Zone	Site	Investigation Category	Rationale
	FDTA-2	II	Contamination of soil and groundwater by screening protocols of TOX and O&G, potentially capable of off-site migration. Potential for contamination of fractured bedrock aquifer. Further investigation needed to identify specific contaminants, lateral and vertical distribution, hazard level, and to recommend source containment/removal options
1	BFSA	I	Results of TOX, TOC, and O&G analyses indicate no significant contamination problems in wells and surface water. Wells are appropriately sited to monitor groundwater quality downgradient of site.
1	LF-2, LF-3, LF-4, and LF-5	II	Contamination of surface water by low levels of As, Pb, and a DDT isomer. Orange precipitate suggests presence of landfill leachate. Further investigation necessary to confirm and quantify surface water quality impacts relative to hazardous substances. No groundwater contamination detected. Wells appropriately sited to monitor groundwater downgradient of sites.
2	FDTA-1	II	Screening protocols in downgradient well at "background". Soil contamination by O&G is elevated. Further investigation necessary to identify specific contaminants posing hazard, if any, and to evaluate any potential hazards from direct contact or through runoff. Possibility of groundwater discharge to Peverly Pond and/or unnamed stream north of site.

Table S-3 (cont.)

SUMMARY OF SITE-SPECIFIC CONCLUSIONS
PEASE AFB, PHASE II STAGE 1 IRP INVESTIGATION

Zone	Site	Investigation Category	Rationale
2	LF-1	I	Downgradient wells exhibit background to low TOX, TOC, and O&G. Low TOX, TOC, and O&G detected in surface waters. Specific conductance and iron concluded to be above background in downgradient wells. HNu readings at wells within background values. No significant impacts on surface water quality detected. Priority pollutant metals detected in various concentrations in up- and down-gradient wells not concluded to be directly attributable to LF-1.
3	IS/PA	II	Contamination by screening protocols (TOX and O&G), selected metals, phenols, and Priority Pollutant VOC in soils at up to 7 locations: Building 113 - O&G, VOC Building 119 - TOX, O&G, phenols, VOC Building 120 - TOX, O&G, phenols, lead Building 222 - TOX, O&G, VOC Building 226 - TOX Building 229 - O&G Building 244 - VOC Groundwater quality throughout the zone was consistent with anticipated background quality. Elevated concentrations of contaminants in soils presents the possibility of future bedrock and/or unconsolidated aquifer contamination. Proximity of areas of contamination to drainage ditches presents the possibility of localized flow discharge of contaminants.

Table S-3 (cont.)

SUMMARY OF SITE-SPECIFIC CONCLUSIONS
PEASE AFB, PHASE II STAGE 1 IRP INVESTIGATION

Zone	Site	Investigation Category	Rationale
			One underground storage tank (Building 244) contains a liquid with elevated VOC levels (Table 4-14). Further investigation necessary to determine extent of significant soil contamination and possible impacts on receptors including surface water quality in areas where VOCs detected.
4	McIntyre Brook	I	Results of TOX, O&G, and TOC at background, and all metals within state MCLs in surface water. O&G level in sediment is background to low. No visually stressed conditions observed. Storm drainage passes through oil separator prior to discharge to brook. Brook sampled as part of base NPDES program.
4	Newfields & Grafton Ditches	II	Elevated levels of TOX, O&G, and lead detected in sediments. Oil sheen on surface water during sediment sampling. Further investigation necessary to quantify sediment quality and determine potential impact on surface water quality.
4	Base Production Wells[(1)]	I	Lead detected at State MCL in MMS-2 on one occasion but not detected during second round. No other contamination detected in excess of State MCLs. Low levels of VOCs found in Haven, MMS and Loomis Wells. Base personnel sample all production wells quarterly for VOCs. Discharge from Haven, Harrison, and Smith Wells is treated for VOCs at base treatment facility. No further IRP investigation recommended.

Table S-3 (cont.)

SUMMARY OF SITE-SPECIFIC CONCLUSIONS
PEASE AFB, PHASE II STAGE 1 IRP INVESTIGATION

Zone	Site	Investigation Category	Rationale
	MSA	I	Low concentrations of TOC and O&G detected in soils in stained areas. Lateral and vertical extent of soil staining very limited. HNu readings at background in power auger holes. Background concentrations of TOX and TOC in surface waters. O&G results in surface water variable, and not concluded to be attritutable to suspect site based on site investigation. No further IRP action warranted.
	CRD-1	II	Second round surface water sample from SW-10 contained elevated TOX. Resamples from SW-10 and SW-12 (Figure 3-17) contained elevated O&G. All surface water samples potentially in downgradient groundwater flow path from CRD-1 and FDTA-2. Additional sampling with specific protocols (VOC, BNA) required to identify and to assess potential impact to Upper Peverly Pond (located downstream of SW-10).
	CRD-2	I	Low TOX detected in downgradient well adjacent to fill deposits, but HNu Readings at background from well. Background TOC and O&G in well, Elevated specific conductance values in groundwater from well, but no priority pollutant metals exceeding State MCLs attritbutable to fill operations. Site in ground discharge zone. Background concentrations of TOX, TOC, and O&G in adjacent surface waters.

(1) Potential receptor; not a site.

Table S-3 (cont.)

SUMMARY OF SITE-SPECIFIC CONCLUSIONS
PEASE AFB, PHASE II STAGE 1 IRP INVESTIGATION

Zone	Site	Investigation Category	Rationale
5	LF-6	II	Contamination in groundwater by TOX, TOC, O&G, phenols, and in situ measurements (specific conductance and VOC by HNu). Site within 1800 feet of base boundary and abuts wetlands. Further investigation necessary to identify specific compounds, to define vertical and horizontal groundwater flow patterns, and quantify nature and extent of contamination by hazardous substances.
	LFTS and Site 22 (Suspect Fire Training Area)	II	Elevated O&G detected in two wells near sources. Elevated O&G concentrations in soils near two sources. Elevated HNu readings during well drilling and test pits investigations. Buried drums encountered during test pit operations. Site underlain by permeable sand and gravel. Additional investigation necessary to identify specific VOCs, if any, and define extent of contamination in soils and waters. Confirmation of all potential drum burial sites.
6	FLS	I	Elevated TOX level in one small area of stained soil (1-2 ft diameter). No VOCs detected in sample from the same site. No contamination by O&G found in downgradient monitoring well.
6	FMS	I	Elevated TOX and O&G concentration in soils in isolated stained area. Low TOX, TOC, and O&G in well samples. Visual examination of soils beneath stained area indicate no contamination with depth. Groundwater results do not reveal evidence of contamination.

(1) Potential receptor; not a site.

TABLE S-4

SUMMARY OF INVESTIGATION RECOMMENDATIONS

Zone	Site	Recommendations	Level of Effort
-	Site 8- FDTA-2	o Aerial photo reassessment	o Fracture trace analysis.
		o Resampling of existing wells	o 2 rounds - full quantification effort for VOCs, BNAs, PNAs, PCBs, and GC fuels analysis (10 samples).
		o Install additional monitoring wells	o Three multi-level well installations and sampling; six samples for VOCs, BNAs, and GC fuels analysis.
		o Test pit/soil sampling in burnpit	o Full quantification effort for VOCs, BNAs,PNAs, PCBs, and GC fuels analysis (10 samples).
		o Soil-gas testing	o Field GC analyses to complement quantification effort.
1	Sites 2,3,4,5 - LF-2, LF-3, LF-4, LF-5	o Resampling surface waters and groundwaters	o Resample at three locations, 2 occasions for VOCs, Herbicides/Pesticides, and selected metals.

Notes: VOC = Volatile Organic Compound
BNA = Base Neutral/Acid Extractable
PNA = Polynuclear Aromatic
PCB = Polychlorinated Biphenyl
GC = Gas chromatography

TABLE S-4 (Continued)

SUMMARY OF INVESTIGATION RECOMMENDATIONS

Zone	Site	Recommendations	Level of Effort
2	Site 7 - FDTA-1	o Resampling of surface and groundwaters	o 2 Rounds - 10 samples for VOCs, BNAs, and PNAs.
		o Supplemental soil borings/test pits	o Full quantification efforts for VOCs, BNAs, and PNAs (10 samples).
		o Soil-gas testing	o Field GC analysis to complement quantification effort.
		o Install additional monitoring wells	o Three multi-level well installations and sampling; 6 samples for VOCs, BNAs, and PNAs.
3	Site 15 - IS/PA	o "Expedited Remedial Action" at buried tank at Building 244	o Removal and testing of liquid contents (RCRA), testing of soils for VOCs around tank.
		o Soil borings/soil sampling	o Localized quantifications study at seven potential sources for VOCs, BNAs, and selected metals.
		o Soil-gas testing	o Field GC analyses to complement quantification analyses.

Notes: VOC = Volatile Organic Compound
BNA = Base Neutral/Acid Extractable
PNA = Polynuclear Aromatic
PCB = Polychlorinated Biphenyl
GC = Gas chromatography

TABLE S-4 (Continued)

SUMMARY OF INVESTIGATION RECOMMENDATIONS

Zone	Site	Recommendations	Level of Effort
3	Site 15 (cont.)	o Surface water/sediment sampling	o Confirmation effort at sites adjacent to wetlands/streams (Bldgs. 222, 113, 119 and 229).
		o Resampling existing monitoring wells	o 2 rounds - 14 samples for VOCs and selected metals; 7 samples for BNAs
		o Removal of tank at Building 113	o Tank removal, if warranted by supplemental investigations.
		o Install additional wells	o Four multi-level well installations and sampling; eight samples for VOCs, BNAs, and selected metals.
4	Sites 19 & 20 Newfields & Grafton Ditches	o Expanded sediment sampling program	o Localized quantification effort for VOCs, BNAs, and selected metals (12 samples).
		o Resampling surface waters	o 2 rounds, 10 samples for VOCs, BNAs, and selected metals.
		o Aquatic biological investigation/ receptor analysis	o Based on Stage 2 analytical findings.
	Site 9, CRD-1	o Expansion of surface water quality monitoring	o 3 rounds - 9 samples for VOCs to determine site-specific water quality constituents.

Notes: VOC = Volatile Organic Compound
BNA = Base Neutral/Acid Extractable
PNA = Polynuclear Aromatic
PCB = Polychlorinated Biphenyl
QC = Gas chromatography

TABLE S-4 (Continued)

SUMMARY OF INVESTIGATION RECOMMENDATIONS

Zone	Site	Recommendations	Level of Effort
5	Site 6, LF-6	o Aerial photo reassessment	o Fracture trace analysis.
		o Test pit investigation/soil-gas investigation	o Define fill limits and waste characteristics.
		o Install additional monitoring wells	o Five multi-level well installations and sampling; five samples for VOCs, BNAs, and selected metals.
		o Expand surface and groundwater sampling protocols	o 40 samples for VOCs and selected metals with 20 of these samples for BNAs.
		o Geophysical investigation	o Define fill limits and potential migration pathways.
		o Aquatic biological investigation/receptor analysis.	o Based on Stage 2 analytical findings.
		o Groundwater modeling	o Analytical models for flow and transport, if necessary.

Notes: VOC = Volatile Organic Compound
BNA = Base Neutral/Acid Extractable
PNA = Polynuclear Aromatic
PCB = Polychlorinated Biphenyl
QC = Gas chromatography

TABLE S-4 (Continued)

SUMMARY OF INVESTIGATION RECOMMENDATIONS

Zone	Site	Recommendations	Level of Effort
	Sites 10 & 22 LFTS and Site No. 22	o Aerial photo reassessment	o Detailed effort to define suspect burial/burn sites.
		o Non-destructive testing	o Detailed GPR/EM survey to define limits of burial sites (including confirmatory test pits).
		o "Expedited Remedial Action" at drum burial site	o Removal of drums and associated contaminated soils, RCRA chemical characterization of 6 samples, and off-site disposal.
		o Expanded test pit/soil boring and sampling program	o Localized quantification effort of 12 samples for VOCs, GC fuels analysis, and lead; 6 selected analyses for BNAs and PNAs at Site 22.
		o Resampling of existing monitoring wells	o 2 Rounds - 6 samples for VOCs and lead; 3 selected BNAs and PNAs.
		o Install additional monitoring wells	o Three multi-level well installations and sampling; 6 samples for VOCs, lead, BNAs, and PNAs.
		o Groundwater modeling	o Analytical modeling analysis.

Notes: VOC = Volatile Organic Compound
BNA = Base Neutral/Acid Extractable
PNA = Polynuclear Aromatic
PCB = Polychlorinated Biphenyl
GC = Gas chromatography

It is recommended that the contents of the tank at Building 244 be removed and placed in suitable containers for analysis prior to disposal, and that the tank be excavated and disposed with the containerized soil and liquid wastes in such a manner so as to comply with applicable State and Federal regulations. The soils in the vicinity of the tanks should be sampled and tested for volatile organic contaminants. Soil-gas testing should be performed to supplement laboratory test data.

The buried drums at LFTS should be excavated, placed in suitable "overpack" containers, and removed from the site. The contents of the drums and the soils beneath the drums should be sampled and analyzed to fully characterize their contents prior to their removal from the site. The fully characterized and containerized wastes should be transported to an approved waste disposal site capable of accepting the type of wastes characterized.

SECTION 1

INTRODUCTION

1.1 INSTALLATION RESTORATION PROGRAM

The purpose of the Installation Restoration Program (IRP) is to assess and control the potential migration of environmental contamination that may have resulted from past operations and disposal practices on DoD facilities. In response to the Resource Conservation and Recovery Act of 1976 (RCRA), and in anticipation of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA, or "Superfund"), the DoD issued a Defense Environmental Quality Program Policy Memorandum (DEQPPM 80-6), requiring identification of past hazardous waste disposal sites on DoD installations. The U.S. Air Force implemented DEQPPM 80-6 in December 1980. The program was revised by DEQPPM 81-5 (11 December 1981), which reissued and amplified all previous directives and memoranda on the IRP. The Air Force implemented DEQPPM 81-5 on 21 January 1982. The Installation Restoration Program has been developed as a four-phase program, as follows:

- Phase I - Problem Identification/Records Search
- Phase II - Problem Confirmation and Quantification
- Phase III - Technology Base Development
- Phase IV - Corrective Action

Only the Phase II Stage 1, problem confirmation portion of the IRP effort at Pease Air Force Base (Pease AFB) is included in the effort described in this report. Definitions of the acronyms, nomenclature, and units of measurement used in this report are included in Appendix A.

1.2 PROGRAM HISTORY AT PEASE AIR FORCE BASE

Roy F. Weston, Inc. (WESTON) had been retained by the United States Air Force Occupational and Environmental Health Laboratory (USAFOEHL), under Basic Ordering Agreement (BOA) Contract Number F33615-80-D-4006, to provide the Air Force with general engineering, analytical, and hydrogeological

[illegible]. The Phase I, Problem Identification/Records Search for Pease AFB was accomplished by CH2M Hill in late [illegible], and their Final Report was dated January 1984. In response to the findings contained in the Phase I Final Report, the USAFOEHL issued Task Order 0039 to WESTON, directing that a presurvey be conducted at Pease AFB. The purpose of this presurvey was to obtain sufficient information to develop a work scope and cost estimate for the conduct of a Phase II Stage 1 Problem Confirmation Study at Pease AFB.

Based upon the conclusions of the Phase I Records Search, the Phase II Presurvey Report, and the overall HARM score ratings, sixteen sites at Pease AFB were recommended for Phase II Stage 1 Confirmation Study Investigations. Two sites listed in Phase I Report (Site 16: PCB spill site, and Site 18: Munitions Residue Burial Site) were not recommended for further study. Three additional sites (Sites 19, 20, and the Newfields Ditch, Grafton Ditch, and McIntyre Brook) were added to the list of sites requiring further study, bringing the total to nineteen sites. An additional suspected fire training area was identified from aerial photographs prior to the start-up and Stage 1 field activities. This new site was named Site 22, and brings to twenty the number of sites investigated during the Phase II Stage 1 Study.

The presurvey report for Pease AFB was submitted by WESTON in June 1984. In September 1984, WESTON was issued a new contract (Contract Number F33615-84-D-4400) by USAFOEHL. The scope of work, dated 30 July 1984, was issued as Task Order 0005 and authorized a Phase II Stage 1 study for 19 sites at Pease AFB. The Task Order was subsequently revised, on 28 November 1984, and 1 May 1985. A new (20th) site was identified during the initial study stages and incorporated into the Phase II investigation. A copy of the revised Task Order (000502) is included herein as Appendix B.

A pre-performance meeting, including representatives of WESTON, USAFOEHL, Pease AFB, and the drilling subcontractor, ConTec., Inc., was held on 17-18 October 1984 to review the goals of the investigation, to review drilling procedures and locations, and to establish the field schedule. Field work began on 25 October 1984 and was completed on 27 January 1986. Methods, findings, and recommendations for additional work based on the results of this investigation are summarized in this report.

1.3 BASE PROFILE

1.3.1 Base History and Current Organization

Pease AFB is located on 4,365 acres of land in the communities of Portsmouth and Newington in Rockingham County, New Hampshire. Other nearby communities (within 10 miles) include Dover, Greenland, New Castle, Rye, and Rye Beach in New Hampshire, and Kittery and York in Maine. The nearest major commercial jet airport is located in Boston, 55 miles to the south. Access to the main entrance to Pease AFB (Newington Road) is provided via the Spaulding Turnpike (U.S. Route 4). Figure 1-1 is a location map of Pease Air Force Base. The current base boundaries are shown in Figure 1-2.

Pease AFB saw its first military use during World War II when it was leased by the U.S. Navy. In 1946, the Navy waived exclusive rights to all but 450 acres of the facility. The facility was subsequently transferred to the USAF in 1951. Following a series of USAF inspections, the present site was chosen for development of an Air Force base because of its proximity to existing utilities and availability of good transportation facilities. Inspection reports also cited the feasibility of the site from the standpoint of infrastructure, public relations, and availability of land for expansion. Additional land was acquired in 1952 and 1953, with construction beginning about 1954.

In 1956, the 100th Bombardment Wing began operation at the base, then known as Portsmouth Air Force Base. In February 1956, the 817th Air Division was activated here and was redesignated the 45th Air Division in 1971, with two more wings assigned to it. The first B-47 aircraft arrived in April 1956, and by the end of that year all B-47's and KC-97 tankers assigned to the wing had arrived. In September 1957, Portsmouth AFB officially became Pease AFB, in honor of Captain Harl Pease, Jr.

In August 1958, the 100th Bombardment Wing was joined by the 509th Bombardment Wing. In February 1966, the last B-47's and KC-97's departed the base. The base also lost the 100th Bombardment Wing to Davis-Monthan AFB, Arizona; however, the New Hampshire Air National Guard Unit from Grenier Field in Manchester was assigned to Pease AFB. The 509th Bombardment Wing remained and was re-equipped with B-52 and KC-135 aircraft transferred from Sheppard AFB, Texas.

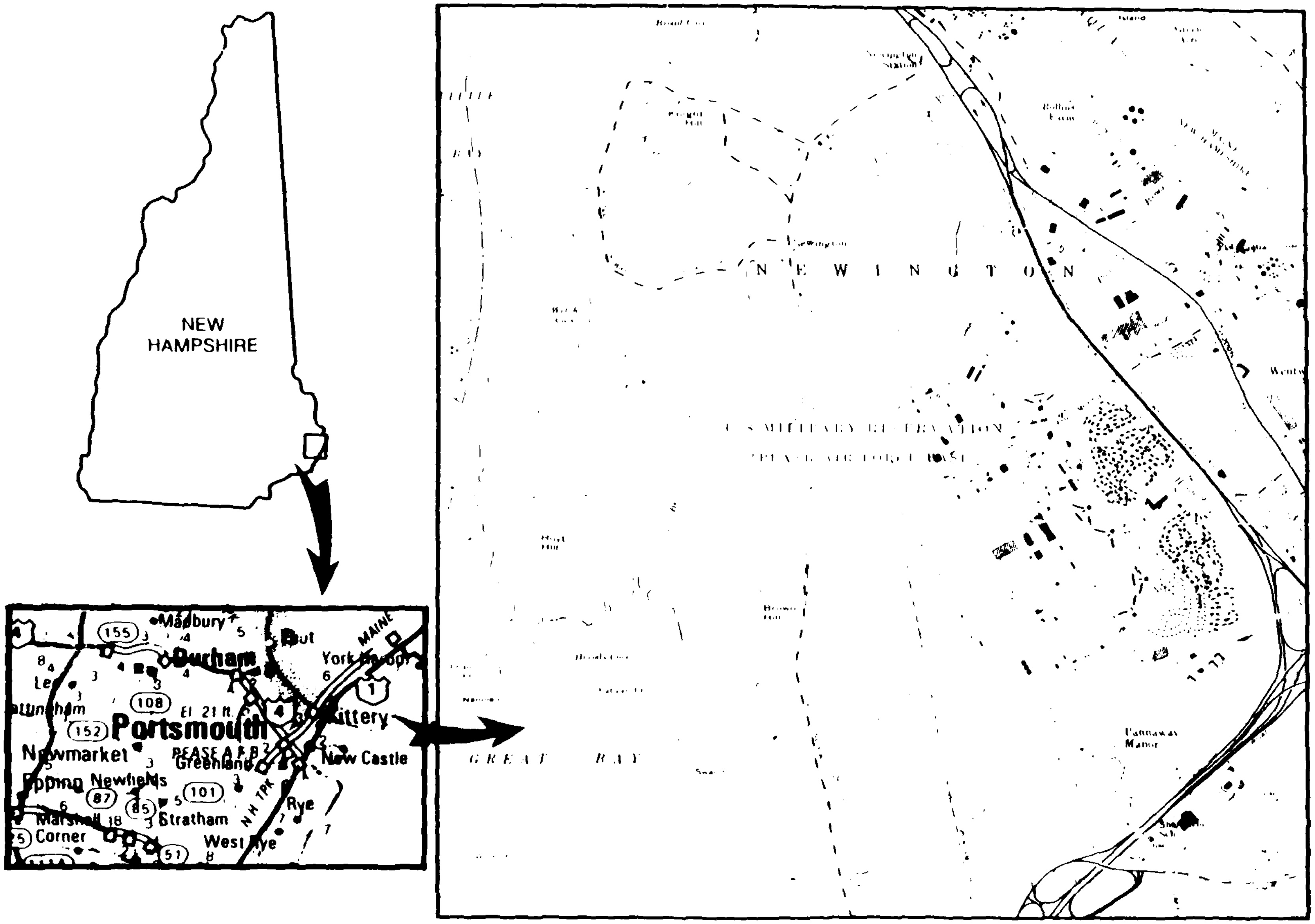


FIGURE 1-1 INDEX MAP OF PEASE AIR FORCE BASE

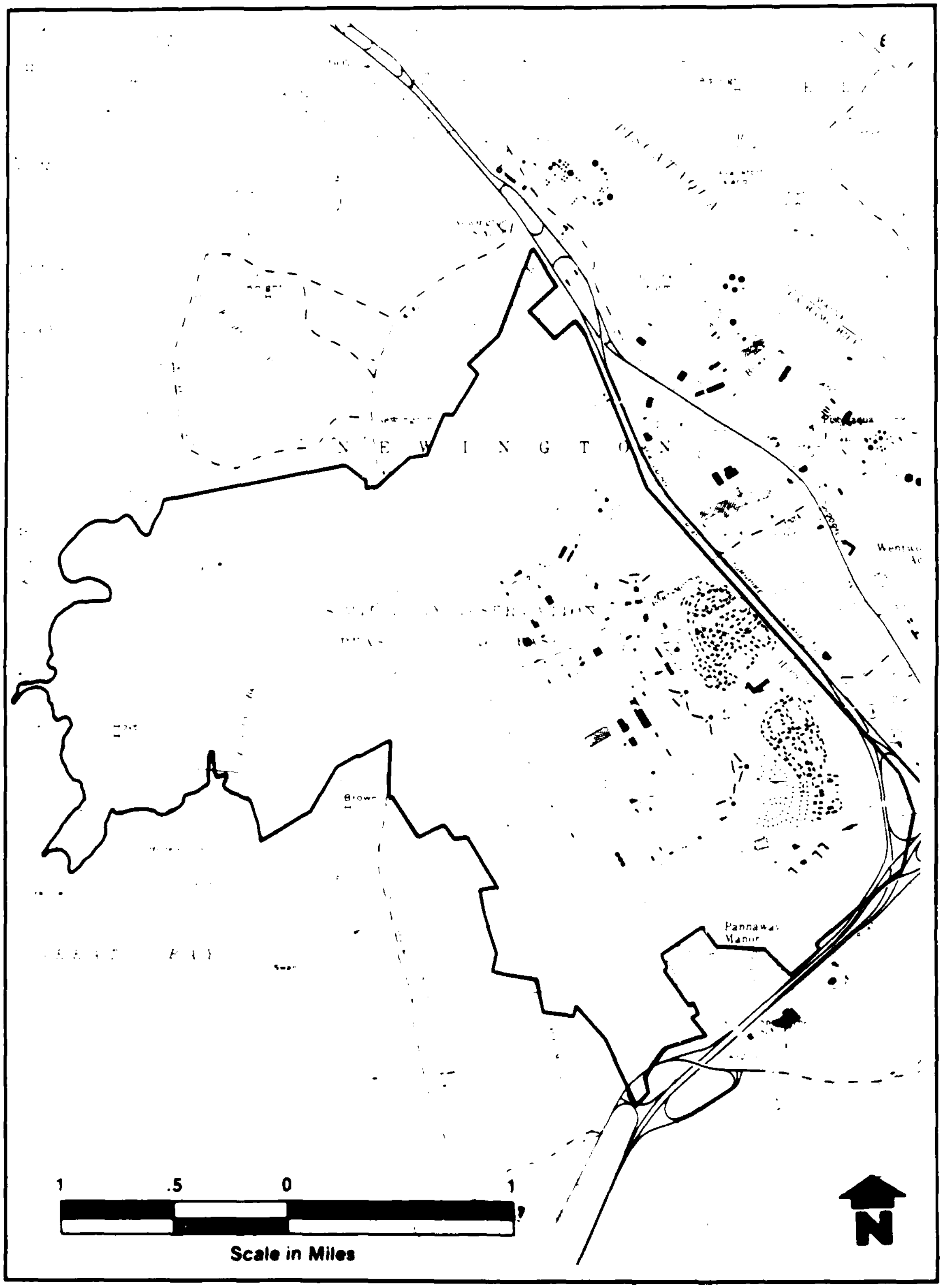


FIGURE 1-2 BASE MAP - PEASE AFB

In June 1966, the 34th Air Refueling Squadron arrived from Offutt AFB, Nebraska and in August 1967, the 54th Aerospace Rescue and Recovery Squadron arrived from Goose AFB, Labrador. Later in 1967, the 817th Combat Support group was redesignated the 509th Combat Support Group. In May 1969, it was announced that the 509th Bombardment Wing would receive the first two operational squadrons of FB-111A aircraft. December 1969 marked the redesignation of the 509th as a Medium Bombardment Wing. On New Year's Day, 1970, the 715th Bombardment Squadron was reactivated. The Wing received its first FB-111A on 16 December 1970 and became fully operational in 1971.

The land and associated facilities of Pease AFB are presently used to support the strategic mission of the base and 15 tenants including the 45th Air Division. The four organizations that have primary flying missions are the 393rd and 715th Bombardment Squadrons, which are authorized FB-111A Aircraft, and the 34th (scheduled for inactivation) and the 509th Air Refueling Squadrons which are authorized KC-135 aircraft. The 157th Air Refueling Group, which is a New Hampshire Air National Guard Unit and a tenant on the base, also flies the KC-135 aircraft. The primary mission of the 509th Bombardment Wing is to maintain a combat-ready force capable of conducting long-range bombardment operations. The primary mission of the 157th Air Refueling Group is to provide tactical airlift support for airborne forces and other personnel, equipment, and supplies. The 157th Air Refueling Group is an operational and training unit.

1.3.2 History of Waste Disposal Operations

Past activities at Pease AFB in support of aircraft maintenance operations have resulted in the generation of small quantities of hazardous wastes, including spent degreasers, solvents, paint strippers, and contaminated jet fuels. From the Phase I report, the total quantity of the above hazardous wastes has been estimated to be 1,500 to 2,000 gallons per year. In addition, approximately 14,000 gallons per year of waste oils (engine oils, and petroleum and solvent wastes such as hydraulic fluid, PD-680, MOGAS, diesel fuel, and JP-4) and 10,000 gallons per year of reclaimed JP-4 are generated. Contaminated JP-4 (estimated volumes of 15,000 gallons per year) is used in fire department training exercises.

Standard industrial waste disposal practices at Pease AFB have been:

1956-1971	- Fire Department Training Exercises
1971-1982	- Contractor Removal
1971-Present	- Contractor Removal through the Defense Revitilization and Marketing Office (DRMO)

1971-Present - Contaminated JP-4 Used in Fire Department Training Exercises

Reclaimed JP-4 Returned to Bulk Storage

In addition, landfilling of various combinations of wastes has occurred at six sites within the base boundaries. Eighteen past disposal or spill sites have been identified at Pease AFB. Figure 1-3 is a map showing the locations of these sites. Table 1-1 summarizes disposal practices and dates of operation for all 18 sites.

Each site was rated by CH2M Hill (1984) during Phase I activities in accordance with the IRP Hazard Assessment Rating Methodology (HARM). The results of these ratings are summarized in Table 1-2. Sites 17 and 18 were not given a HARM rating because materials disposed at those sites were inert and were not considered potential sources of contamination.

At the time of the presurvey site inspection in May 1984, three additional sites (designated as Sites 19, 20, and 21) were identified. These were outfalls from the storm drainage system located on perimeter drainageways: (Site 19) Newfields Ditch, (Site 20) Grafton Ditch, and (Site 21) McIntyre Brook. The active base supply wells were included in a single investigation zone with these three sites. Also during the presurvey, two sites were eliminated from consideration for Phase II investigation: Site 16 (the PCB Spill Site) was eliminated because complete clean-up of contamination had already been accomplished by the base; Site 18 (the Munitions Residue Burial Site) was eliminated because only inert materials were reportedly disposed of at the site.

A total of nineteen sites were initially investigated in this Phase II Stage 1 Study. For the purposes of site investigation, fifteen of the sites were grouped into six investigation "zones"; four of the sites were considered separately. Table 1-3 lists the Phase II sites and shows how they have been organized for field investigation. Table 1-3 also provides abbreviated designations for the site names to be used throughout this report. Site locations are shown in Figure 1-3.

While reviewing aerial photographs prior to the onset of test pit investigations at the Fire Department Training Area No. 1 (FDTA-1) and Leaded Fuel Tank Sludge Disposal Site

WESTON

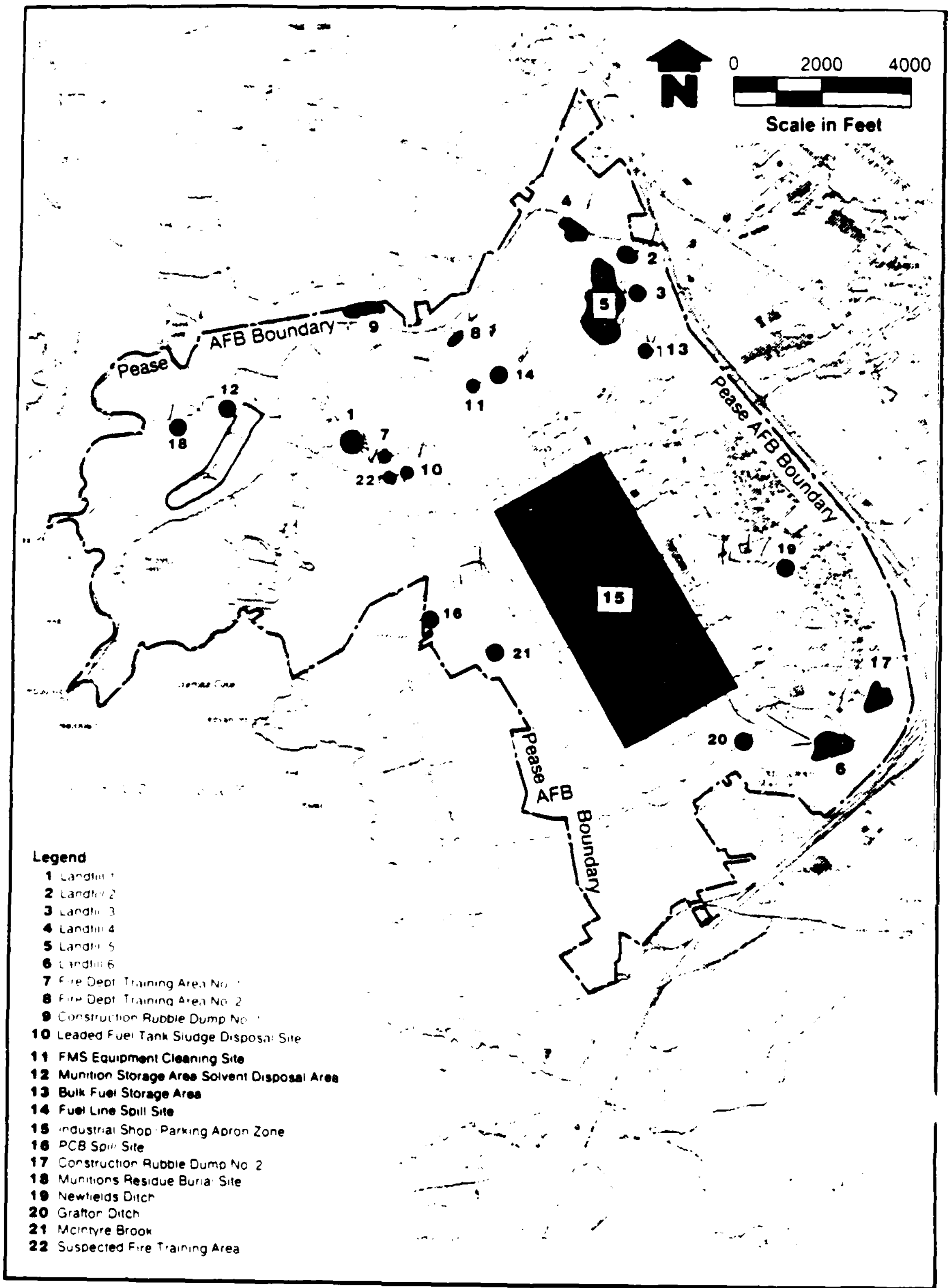


FIGURE 1-3 LOCATION MAP OF IDENTIFIED SPILL AND WASTE DISPOSAL SITES AT PEASE AFB

WESTON

Table 1-1

SUMMARY OF PHASE I SITES
DISPOSAL MATERIALS AND DATES OF OPERATION

Site No.	Site Description	Material Disposed	Dates of Operation
1	Landfill No. 1	Construction rubble, debris, domestic solid waste, waste oils and solvents, paint strippers, outdated paints and paint thinners, pesticide containers, TCE waste	1953 - 1961
2	Landfill No. 2	Domestic solid waste, waste oils and solvents, paints, paint strippers and thinners, pesticide containers and empty cans	1960 - 1962
3	Landfill No. 3	Similar to Landfill No. 2	1962 - 1963
4	Landfill No. 4	Similar to Landfills No. 2 and 3	1963 - 1964
5	Landfill No. 5	Similar to Landfills No. 1 through 4, sludge containing TCE residues	1964 - 1972 1974 - 1975
6	Landfill No. 6	Similar to Landfills No. 1 through 5, but TCE not suspect since it was not commonly used on base during the operation of Landfill No. 6	1972 - 1974
7	Fire Dept. Training Area No. 1	Waste oils, waste fuels, spent solvents burned	1955 - 1961
8	Fire Dept. Training Area No. 2	Various POL wastes, recovered fuels, waste oils, spent solvents - some containing TCE	1961 - 1971
9	Construction Rubble Dump No. 1	Waste solvents containing TCE, construction debris	1958 - 1959 late 1950's - mid-1970's
10	Leaded Fuel Tank Sludge Disposal Area	Rust, water, residual fuel and fuel sludges from large AVGAS tanks and bulk fuel storage area	late 1950's - mid-1970's
11	PMS Equipment Cleaning Site	Waste solvents used to clean new equipment of thin protection cosmolene coating	Prior to 1971
12	Munitions Storage Area Solvent Disposal Site	Waste thinners and solvents, waste solvents containing TCE	Prior to 1980
13	Bulk Fuel Storage Area Spills	JP-4	1963 1975 1980
14	Fuel Line Spill Site	Fuel	1959
15	Industrial Shops Parking Apron	Flight line spills, spent solvent and waste oil spills, disposal of shop wastes into storm sewers	1956 - present
16	PCB Spill Site	Transformer oil containing TCE	1983
17	Construction Rubble Dump No. 2	Inert construction debris	
18	Munitions Residue Burial Site	Inert residue	

WESTON

Table 1-2

PRIORITY LISTING OF PHASE I

Ranking No.	Site No.	Site Description	HARM Rating
1	8	Fire Dept. Training Area No. 2	82
2	13	Bulk Fuel Storage Area Spills	65
3	5	Landfill No. 5	60
3	1	Landfill No. 1	60
5	7	Fire Dept. Training Area No. 1	59
6	12	Munitions Storage Area Solvent Disposal Site	58
7	9	Construction Rubble Site No. 1	55
8	6	Landfill No. 6	54
9	11	FMS Equipment Cleaning Site	53
9	10	Leaded Fuel Tank Sludge Disposal Site	53
9	14	Fuel Line Spill Site	53
12	4	Landfill No. 4	52
13	2	Landfill No. 2	48
13	3	Landfill No. 3	48
15	15	Industrial Shop/Parking Apron Zone	8
16	16	PCB Spill Site	6
17	17	Construction Rubble Dump No. 2	NR
18	18	Munitions Residue Burial Site	NR

NR = NOT RATED

WESTON

Table 1-3

SUMMARY OF PHASE II INVESTIGATION SITES

Zone No.	Site No.	Site Description	Abbreviated Designation
--	8	Fire Dept. Training Area No. 2	FDTA 2
1	13	Bulk Fuel Storage Area Spills	BFSA
	2	Landfill No. 2	LF-2
	3	Landfill No. 3	LF-3
	4	Landfill No. 4	LF-4
	5	Landfill No. 5	LF-5
2	7	Fire Dept. Training Area No. 1	FDTA 1
	1	Landfill No. 1	LF-1
3	15	Industrial Shop/ Parking Apron	IS/PA
4	19	Newfields Ditch	
	20	Grafton Ditch	
	21	McIntyre Brook	
		Base Production Wells	
--	12	Munitions Storage Area Solvent Disposal Area	MSA
--	9	Construction Rubble Dump No. 1	CRD 1
5	6	Landfill No. 6	LF-6
	17	Construction Rubble Dump No. 2	CRD 2
--	10	Leaded Fuel Tank Sludge Disposal Site	LFTS
6	11	FMS Equipment Cleaning Site	FMS
	14	Fuel Line Spill Site	FLS
--	22	Suspected Fire Training Area	Site 22

-- = Considered individually, no zone number

(LFTS), an additional suspected site was identified as Site 22. The site, a possible fire training area, is discussed with adjacent Site 10 in Sections 3, 4, 5 and 6. The following subsections provide brief descriptions of each of the Phase II sites.

1.3.3 Site Descriptions

1.3.3.1 History and Description of Site 8: Fire Department Training Area (FDTA-2)

Site 8, Fire Department Training Area No.2 (FDTA-2), is a site located at the northwest terminus of Taxiway D which was evaluated individually. Figure 1-4 is a location map of the site. The area is cleared and flat, and consists of a large circular burn pit, a drainage ditch leading into an adjacent wooded area, several fuel tanks along the site perimeter, and two abandoned structures.

The use of this site for fire department training activities followed the discontinuation of use of the original Fire Department Training Area (FDTA-1) in 1961, and has continued to the present. Prior to 1975, the training area consisted of a gravel-lined burn pit area. A clay-lined burn area and a drainage system were constructed in 1975. The drainage system was designed to collect seepage and runoff in a clay-lined holding basin with discharge to an adjacent wooded area. An oil/water separator has been planned for the holding basin, and will be installed in "FY87."

From 1961 to 1971, burning exercises conducted at this fire training area were the main method of disposal for various POL wastes generated on base. Products burned included recovered fuels, waste oils, and spent solvents, some of which probably contained waste trichloroethylene (TCE). These wastes were reportedly transported to the site by drum or bowser (portable storage tanks) and dumped onto the training area. Since about 1971, only recovered JP-4 has been used for fire training exercises at this site, with other waste POL products being disposed under a waste removal contract. Training exercises are currently conducted about twice per month with 1,000 to 1,500 gallons of recovered JP-4 used per activity.

A petroleum-like odor is present at the site, and is stronger near an area of stained soil and stressed vegetation which delineates the surface impact of runoff from the burn pit. This area is approximately located as shown in Figure 1-4.

WESTON

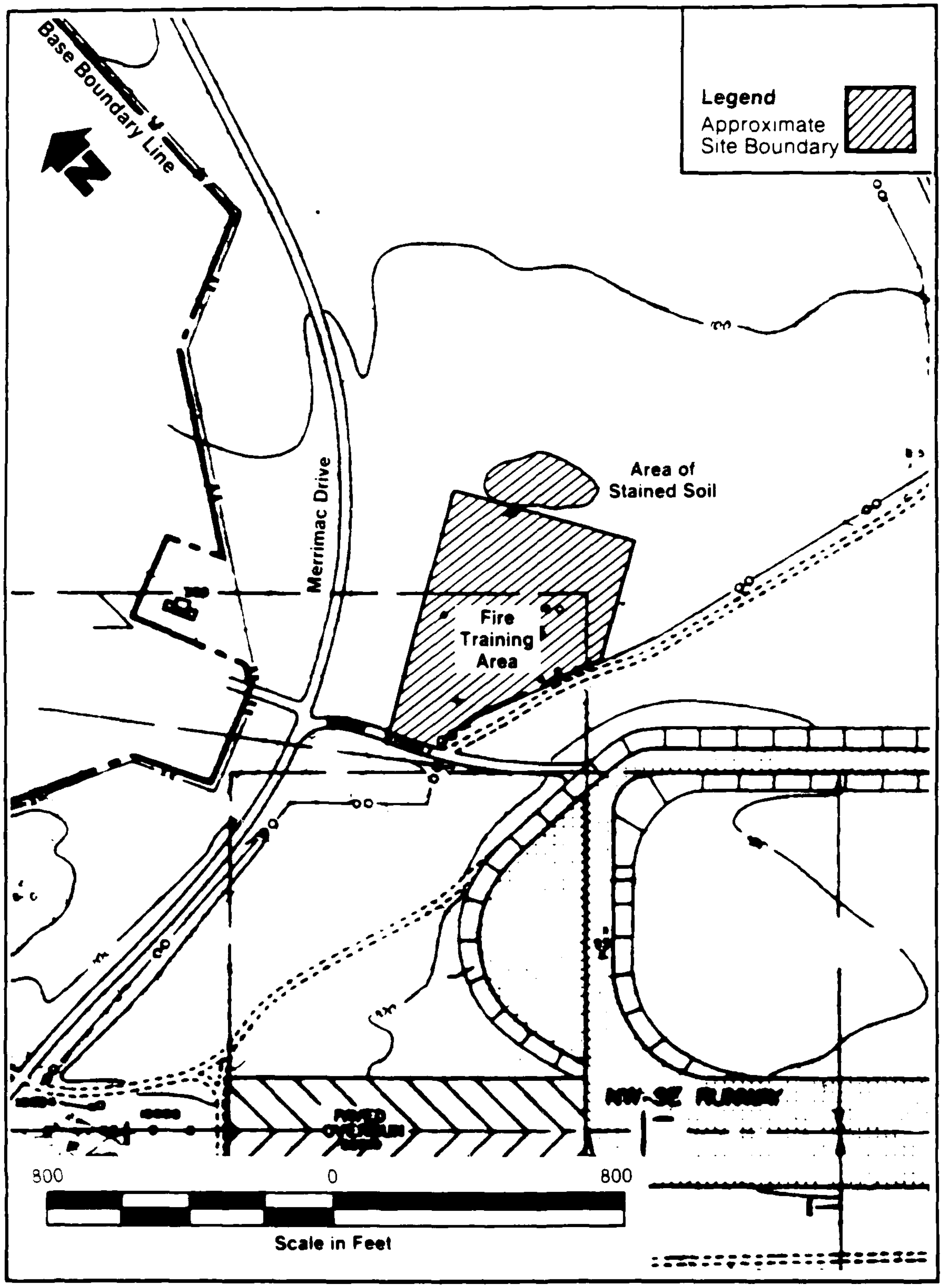


FIGURE 1-4 SITE MAP FOR THE FIRE DEPARTMENT TRAINING AREA NO. 2

The drainage line from the burn area is believed to be functioning improperly, and fuel may periodically flow overland into the low-lying wooded drainage area. The area of acute vegetative stress is approximately 20,000 square feet in size and is not connected by natural surface drainage to surrounding surface waters.

1.3.3.2 Evaluation Zone 1

1.3.3.2.1 History and Description of Site 13: Bulk Fuel Storage Area (BFSA)

The Bulk Fuel Storage Area (BFSA) is located in Zone 1 (Figure 1-5) in the northeast corner of the base adjacent to Portsmouth Avenue. The BFSA consists of three bermed, above-ground storage tanks containing JP-4 and JP-7 fuel. Two of these tanks are 55,000-barrel floating roof JP-4 storage tanks; the third is a 12,500-barrel fixed cone roof JP-7 storage tank. There are also four subsurface tanks located at the Bulk Fuel Storage Area: 1) a 25,000-gallon (JPTS) tank, 2) a 25,000-gallon de-icing fluid tank, 3) a 15,000-gallon MOGAS tank, and 4) a 15,000-gallon diesel fuel tank. Also located within the BFSA are associated support buildings, header pipes and fillstands. Two 10-inch diameter supply pipes enter the BFSA from the northern perimeter of the site and exit from the southern perimeter. The entire facility is enclosed by chain-link and barbed wire fencing.

The BFSA is predominantly flat with some surface runoff to wetlands north and south of the facility. Railroad tracks run along the north and east sides of the site, and a railroad siding enters the site from the east (Figure 1-5).

Throughout its history, a number of fuel spills have occurred at the BFSA. In 1963, a ruptured drain line resulted in the loss of an undetermined amount of fuel from a bulk storage tank. One Phase I interview estimated that up to 100,000 gallons spilled into the diked area surrounding the tank. Most of the spilled fuel was recovered. In 1980, a small leak was discovered from the same tank. Less than 1,000 gallons of fuel were estimated lost before the leak was repaired. In 1975, a loss of an estimated several thousand gallons of fuel occurred at the Bulk Fuel Storage Area due to a corroded vent in the fuel transfer line at Building 160 (Phase I Report, 1984).

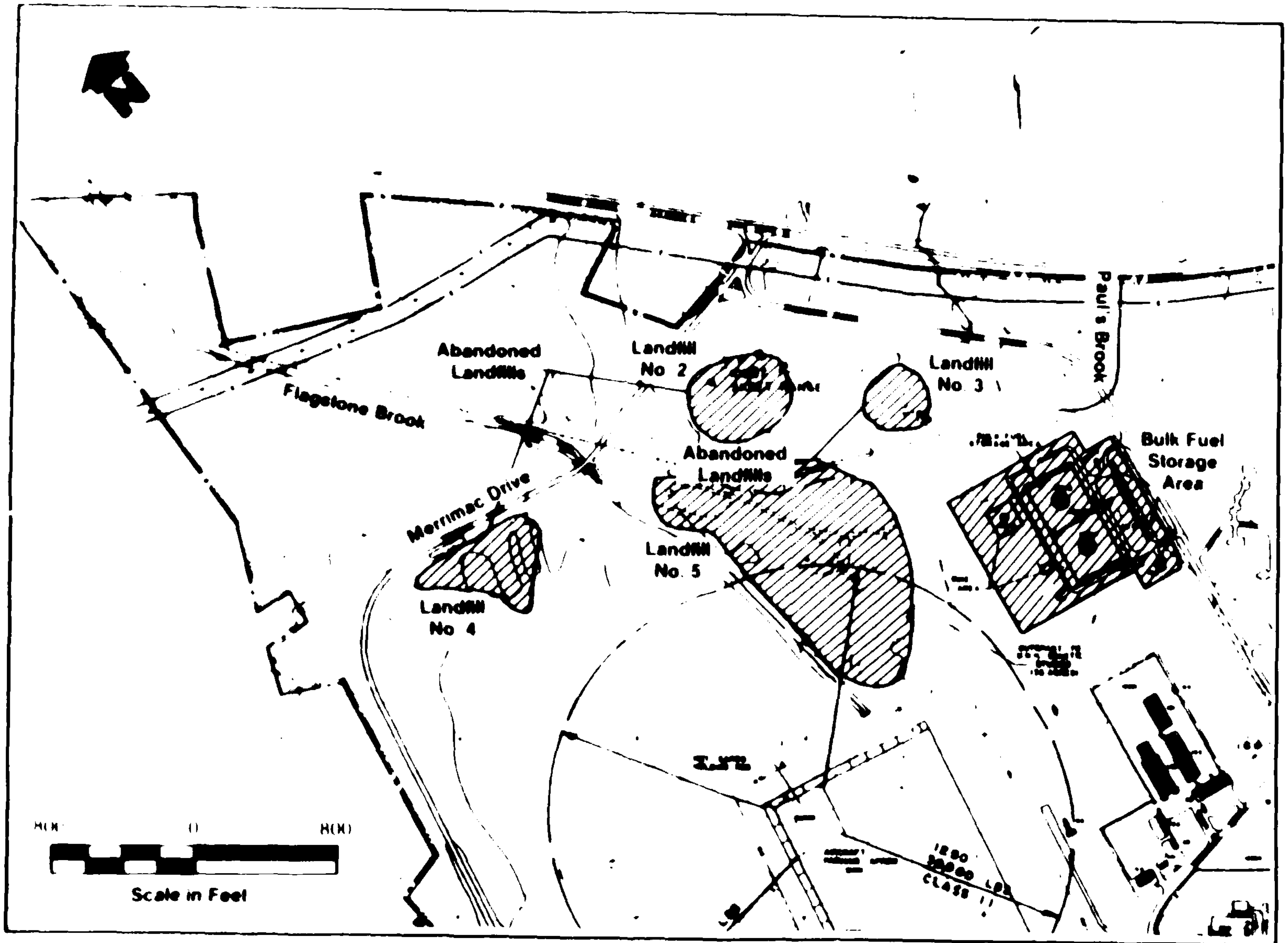


FIGURE 1-5 SITE MAP FOR ZONE I, THE BULK FUEL STORAGE AREA AND LANDFILLS 2, 3, 4 AND 5

1.3.3.2.2 History and Description of Site 2: Landfill No. 2 (LF-2)

Landfill No. 2 (LF-2) is a three-acre site located in Zone 1 along Portsmouth Avenue near the skeet range. It was used for the disposal of domestic solid wastes, waste oils and solvents, paints, paint strippers and thinners, pesticide containers, and various empty cans and drums (Phase I Report, 1984) from 1960 to 1962. The method of disposal was to excavate trenches to maximum depths of six to eight feet (or to bedrock), deposit the wastes, and cover with native fill.

The topography of the site is gently rolling with surface drainage generally flowing westward toward a drainage ditch which parallels the railroad tracks and subsequently discharges into Flagstaff Brook (Figure 1-5).

1.3.3.2.3 History and Description of Site 3: Landfill No. 3 (LF-3)

Landfill No. 3 (LF-3) is a site covering an area of approximately two acres, situated in Zone 1 off Portsmouth Avenue south of LF-2 and north of the Bulk Fuel Storage Area (Figure 1-5). The site was in operation from 1962 to 1963 following the closure of LF-2. LF-3 received wastes similar in nature to those disposed of at LF-2, and disposal was also by trench method.

The topography around LF-3 is flat to gently sloping with depressions containing some wetland areas. Surface drainage is predominantly toward the southwest and subsequently to Flagstone Brook via the drainage ditch along the railroad tracks. The area is now heavily wooded.

1.3.3.2.4 History and Description of Site 4: Landfill No. 4 (LF-4)

Landfill No. 4 (LF-4) is approximately seven acres in size and is located in Zone 1 in the northeast corner of the base, southwest of Merrimac Drive. It was operated subsequent to LF-3 from 1963 to 1964, and the mode of operation and materials received were essentially the same as for Landfills No. 2 and 3. The location of LF-4 is illustrated in Figure 1-5.

The site topography is flat with gentle to moderate (<10 percent) slopes along the east and north perimeters. Surface drainage is to the east toward Flagstone Brook.

Following periods of heavy rain, leachate has been observed flowing north to Merrimac Drive, then east along the pavement toward Flagstone Brook. The site is bounded on three sides by mixed pine and hardwood forests.

1.3.3.2.5 History and Description of Site 5: Landfill No. 5 (LF-5)

Landfill No. 5 (LF-5) occupies 23 acres of land in Zone 1 between the northeast aircraft parking apron and the BFSA (Figure 1-5). It was the major base landfill from 1964 to 1972 and from 1974 to 1975. The mode of operation was trench and fill, similar to the other smaller landfills in the area.

Materials disposed of at LF-5 included domestic solid waste, waste oils and solvents, paints, paint strippers and thinners, pesticide containers, and various empty cans and drums. In addition, the landfill received an estimated 20,000 gallons of sludge from the industrial waste treatment plant (Building 226). According to the Phase I Report (1984), trichloroethylene (TCE) was used in the main shop areas served by the industrial waste treatment plant, and the sludge may also have contained TCE residues. Parts of the site are currently used for stockpiling of sand, gravel, and wood chips. It is also used as a dumping area for grass cuttings.

The site is relatively flat (<5 percent slopes) and open with mixed hardwood and pine forests around the perimeter. Drainage is radial in nature with the bulk of the surface water runoff eventually reaching Flagstone Brook.

1.3.3.3 Evaluation Zone 2

1.3.3.3.1 History and Description of Site 7: Fire Department Training Area No. 1 (FDTA-1)

The original fire department training area is located in Zone 2 (Figure 1-6) west of the northern end of the runway. It was operated from 1955 to 1961. Presently, it includes a circular gravel area approximately 300 feet in diameter with a burn area approximately 100 feet in diameter located in the center of it. Vegetation is absent in the burn area and is sparse in the surrounding area. No indications of oil residues or recent use were found during the Phase I or presurvey site visits.

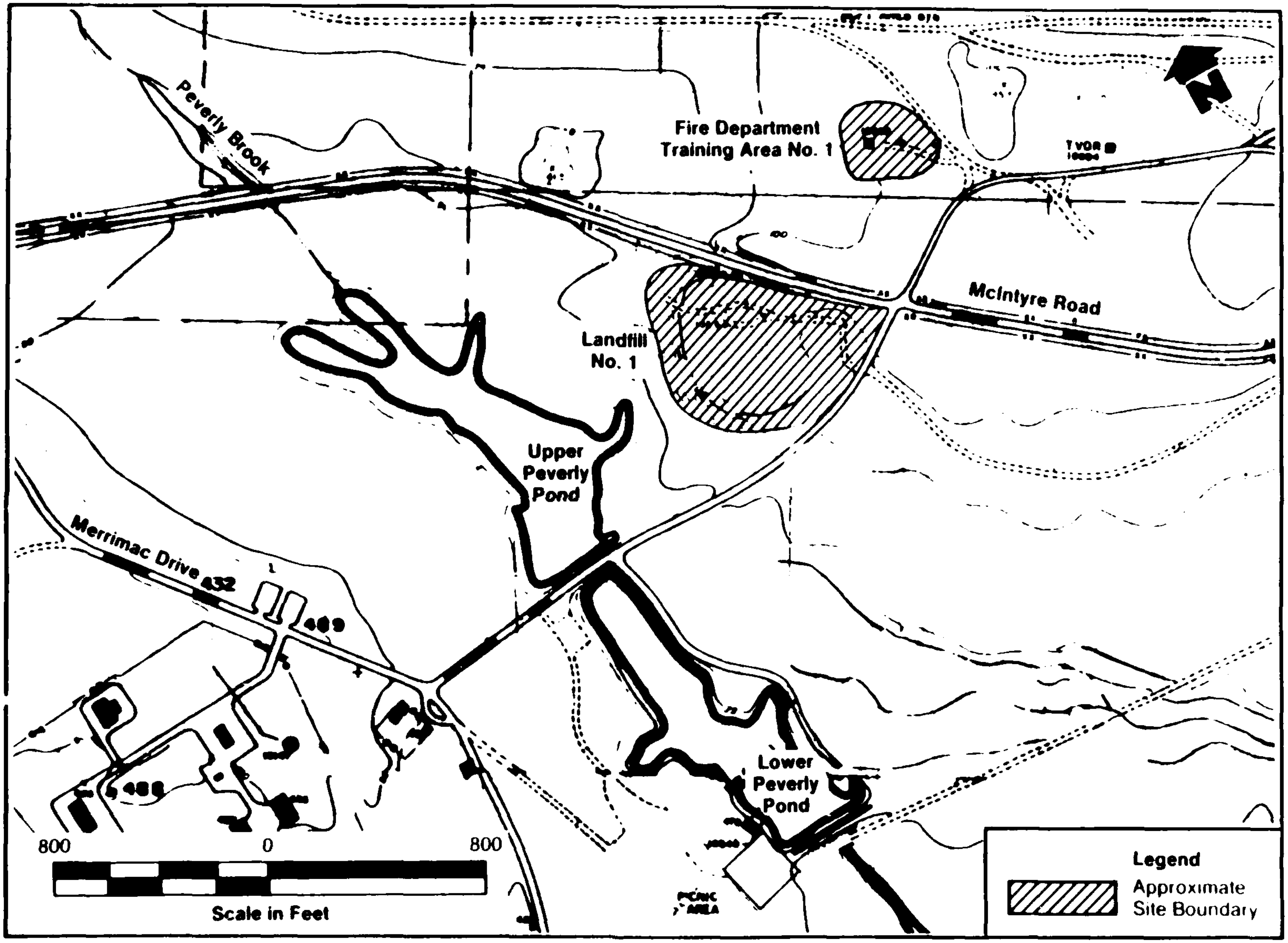


FIGURE 1-6 SITE MAP FOR THE FIRE DEPARTMENT TRAINING AREA NO. 1 AND LANDFILL NO. 1 - ZONE 2

Waste fuels, waste oils, and spent solvents were burned at this site. The volume of wastes burned over the 6-year life of the area was estimated to be 120,000 to 200,000 gallons, with waste fuels accounting for the bulk of material (Phase I Report, 1984).

The site is flat and is situated in a gravel borrow area with steep gravel banks along the western perimeter and no obvious surface drainage pathway.

1.3.3.3.2 History and Description of Site 1: Landfill No. 1 (LF-1)

Landfill No. 1 (LF-1) is located in Zone 2 west of the northern end of the runway and between the east side of Upper Peverly Pond and McIntyre Road (Figure 1-6). Landfill No. 1 was the original base landfill and was operated from 1953 to 1961. The site is situated on a westward trending slope; it developed as refuse was dumped and pushed down the slope, forming a terrace. It is approximately 7 acres in size.

Originally, the landfill received construction rubble and debris from base construction. During base operation, other materials disposed of here included domestic solid wastes, shop wastes, waste oils and solvents, paint strippers, outdated paints, paint thinners, pesticide containers, and various empty cans and drums. The Phase I Study reported that waste solutions from the on-base cadmium plating shop may have been placed in drums and disposed of here, and since TCE was used on the base during the operation of this landfill, TCE waste was probably disposed of here.

The terrace-like landfill roughly parallels McIntyre Road and slopes steeply toward the north and west at the perimeters. Much of the site is overgrown with dense underbrush. Surface drainage eventually flows toward Upper Peverly Pond.

1.3.3.4 Evaluation Zone 3

1.3.3.4.1 History and Description of Zone 3, Site 15: Industrial Shops/Parking Apron (IS/PA)

Zone 3 consists of Site 15, an area containing most of the flightline shops, aircraft hangars, and aircraft parking apron-refueling areas. Figure 1-7 illustrates Site 15.

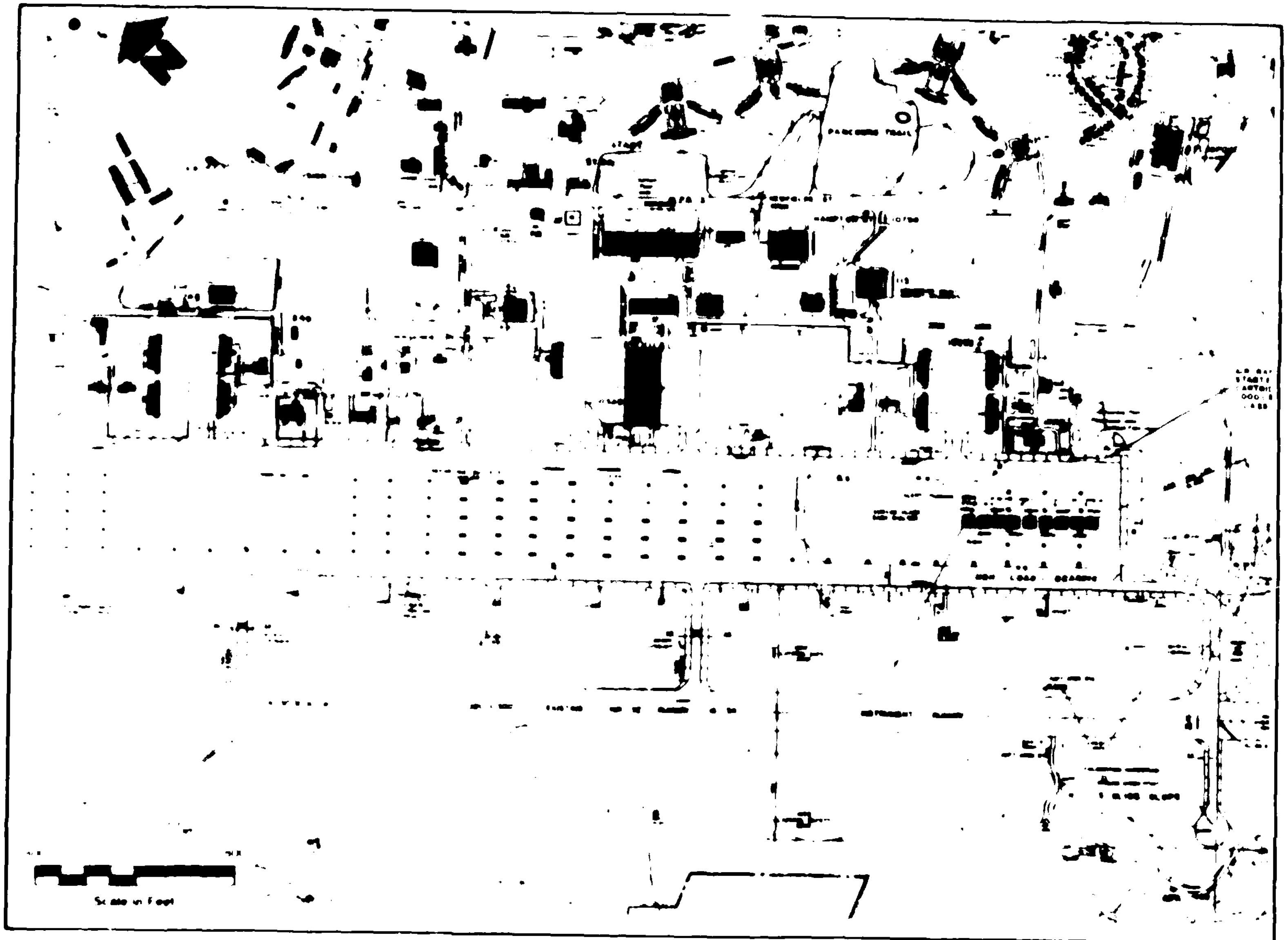


FIGURE 1 7 SITE MAP INDUSTRIAL SHOP/PARKING APRON - PEASE AFB

Since the activation of Pease AFB, Site 15 has historically been an area of numerous, small flightline spills, spent solvent and waste oil spills, and former discharges of shop-generated wastes into storm sewers. Some specific spill incidents or waste disposal practices noted in the Phase I Report (1984) are listed below:

- The effluent from the industrial waste treatment facility (Building 226), operational since the late 1950's, was discharged in early years to the storm drainage system, which ultimately discharges to McIntyre Brook and, thence, to Great Bay. An oil/water separator system was installed on this drainage system in 1974.

- Various waste oils, hydraulic fluid, diesel fuel, JP-4, waste paints, spent solvents (including TCE), paint strippers, and paint thinners were directly discharged to storm drains, washrack drains, sanitary sewers, or disposed of on the ground outside of generating facilities. Spillage from oil/water separators, and overfilling of bowsers and 55-gallon drums also resulted in waste fluids being deposited on the ground or in nearby surface drainage ditches and streams.

- Waste TCE was collected in underground storage tanks located at Buildings 113 and 244. These tanks (1,200 gallons each) were used from 1955 through 1965 to store waste TCE from vapor degreasers used in the maintenance of B-47 weapons systems. One tank (Building 113) was found to contain 1,000 gallons of waste TCE during a 1977 survey. The other tank (Building 244) was found to be empty and may possibly have been leaking (Phase I Report, 1984). These tanks are located relatively close to the Haven well, a base supply well which, in 1977, was found to be producing water contaminated with TCE. TCE usage on the flightline and associated shops was probably highest from 1956 to 1966 when B-47 aircraft were stationed at Pease AFB.

- Oil mixed with solvent wastes were reportedly used in past years as a dust palliative on dirt roads in the vicinity of the industrial shop area.

- The most significant fuel spill reported on the flightline was the release of an estimated 3,000 gallons of JP-4 in the early 1970's due to the rupture of a tanker aircraft wing. Smaller spills (less than 100 gallons) have occurred periodically on the flightline throughout its operational life. Recent excavation of soil for a septic tank leach field in the vicinity of Building 222 revealed fuel-saturated soils in that area.

The topography of the site is flat. Drainage from the area is achieved through a network of storm drains and drainage ditches. Much of the area is paved, which results in high rates of runoff.

1.3.3.5 Evaluation Zone 4

1.3.3.5.1 History and Description of Zone 4: Sites 19, and 21 (Storm Drains)

Zone 4 includes the base storm drain system, various drainage ditches, and the base production wells. Figure 1-8 shows the storm drain system and the location of the three ditches of interest:

Site 19 - Newfields Ditch
Site 20 - Grafton Ditch
Site 21 - McIntyre Brook

Stormwater runoff at Pease AFB is collected in an extensive system of catch basins and is directed through subsurface drains to various receiving streams and ditches which ultimately discharge to either Great Bay or the Piscataqua River. The Phase I report (1984) lists five separate receiving streams or ditches: Flagstone Brook, Pauls Brook, Hodgson Brook, Twin Brook, and the so-called "Receiver Site" (also know as McIntyre Brook). The major discharge points of the storm drainage system are regulated by the New Hamp-

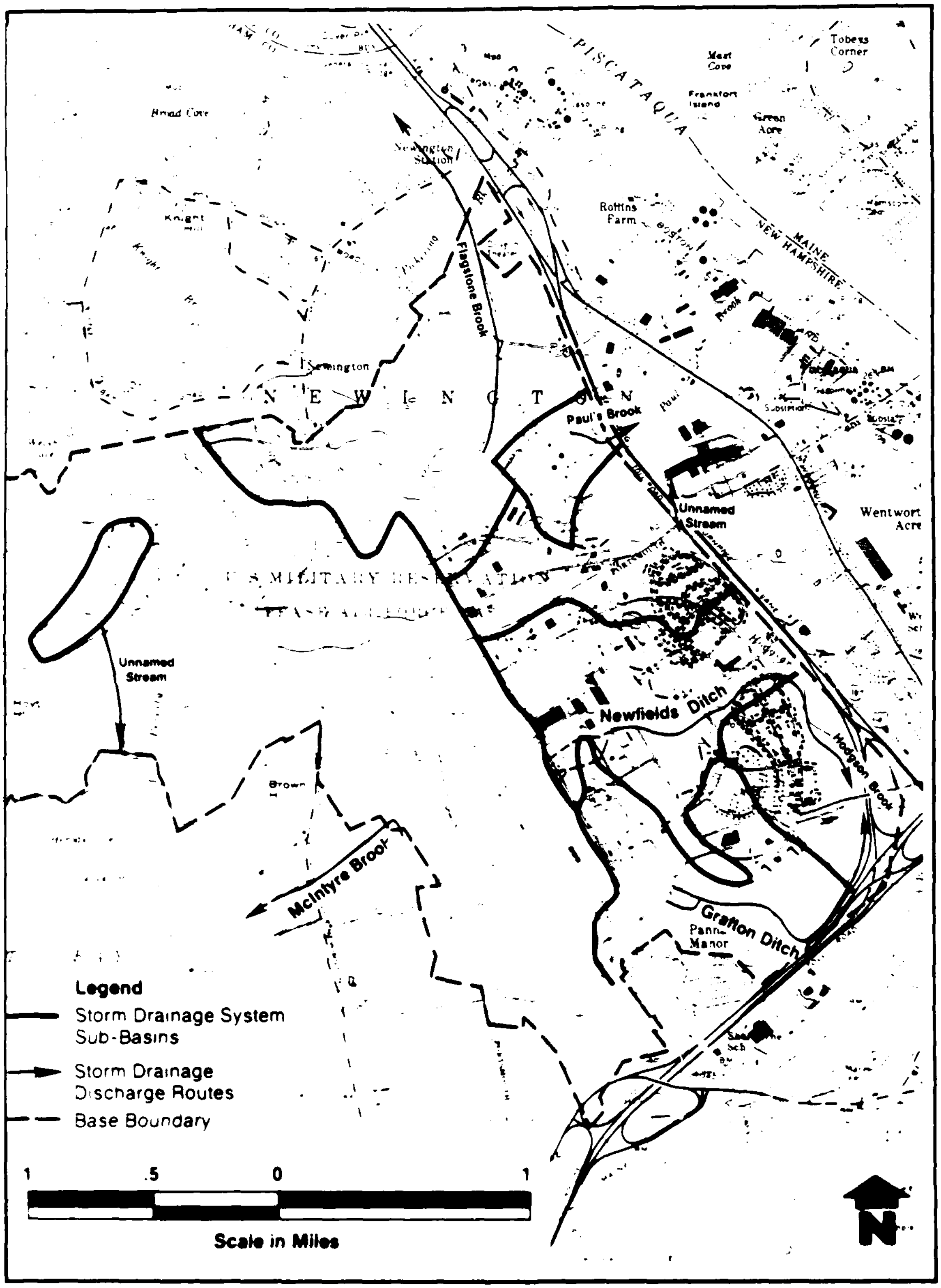


FIGURE 1-8 STORM DRAINAGE SYSTEM - PEASE AFB

shire Water Supply and Pollution Control Commission (NHWS&PCC) under NPDES Permit No. NH0001643. Since the storm drain system collects most of the runoff from the flightline shop area, runway, and the aircraft parking area, concern has been expressed by the NHWS&PCC about its impact on local water quality. The Phase I Report (1984) states (from interviews with base personnel) that waste TCE was disposed of in the industrial area storm drains which discharge to Great Bay.

Flagstone Brook flows in a northerly direction from the north end of the aircraft parking apron at the confluence of two storm drains. These storm drains carry the runoff from the north section of the parking apron. Flagstone Brook continues north, flows beneath Merrimac Road, through a series of concrete oil separators and spillways, and eventually discharges to Little Bay. It has been included in Zone 1 for the Phase II investigation.

Pauls Brook drains an area in the vicinity of the Bulk Fuel Storage Area and flows northeasterly to discharge into the Piscataqua River. It has been included in Zone 1 for the Phase II investigation.

Hodgson Brook drains much of the eastern portion of the base and flows southeasterly, beneath Interstate Route 95, and discharges to the Piscataqua River via North Mill Pond in Portsmouth. Newfields and Grafton Ditches, which are discussed below as Sites 19 and 20, are tributaries of Hodgson Brook, joining it just outside the base boundary adjacent to Routes 4 and 95, respectively.

The Newfields Ditch, Site 19, flows through Site 15, the Industrial Shop Parking Apron Area, to the east where it joins Hodgson Brook. The brook, which is culverted through part of its length, receives overland flow as well as storm runoff from numerous drains in the industrial shop area and through the base housing area.

Grafton Ditch, Site 20, receives storm runoff from the southeastern section of the industrial shop and housing areas, and flows toward the southeast and its confluence with Hodgson Brook.

McIntyre Brook begins at the Receiver Site where a 108-inch storm drain and a 32-inch storm drain discharge. The larger pipe handles runoff from most of the runway and aircraft

parking apron areas. The smaller pipe handles runoff from the southwestern side of the northwest/southeast runway. A portion of the discharge is routed through an oil/water separator before flowing into McIntyre Brook. The brook exits the base to the west and flows to Great Bay.

1.3.3.5.2 History and Description of the Active Base Supply Wells

Figure 1-9 shows the locations of active water supply wells at Pease AFB. A summary of pertinent data for these wells is provided in Table 1-4. Figure 1-10 is a diagrammatic log of the Smith well. The Haven and Harrison wells are similar in construction.

The main supply wells for the base (the Haven, Smith, and Harrison wells) are screened in ice-contact deposits to total depths between 46 and 67 feet. Well yields range from 225 gallons per minute (gpm) in the Harrison well to 800 gpm in the Haven well. Together, they supply approximately one million gallons per day (mgd) to the base. The two Munitions Maintenance Squadron (MMS) wells and the Loomis wells are remote wells not connected to the main supply system; they were drilled through till into bedrock, and were finished as open holes in bedrock. Yields in these wells are significantly lower, ranging from 15 to 29 gpm.

Following complaints of taste and odor problems in the base drinking water supply in 1977, a study was initiated to identify and quantify contamination in the base supply wells. As an interim action, increased pumpage from Harrison and Smith wells was added to the Haven well water to dilute the contaminant concentrations to meet drinking water standards. Additional details on results of earlier investigations are given in Subsection 1.5. Trichloroethylene (TCE) was found to be the principal contaminant; it was found at a maximum level of 391 parts per billion (ppb) in the Haven supply well, and at 28.5 ppb in the Harrison well. Several other volatile organic halocarbons were also found, generally at levels one order of magnitude lower than TCE. In 1984, the wells were equipped with an aeration/carbon absorption treatment system designed to strip volatile organic compounds from groundwater supplied from the Haven, Harrison, and Smith wells.

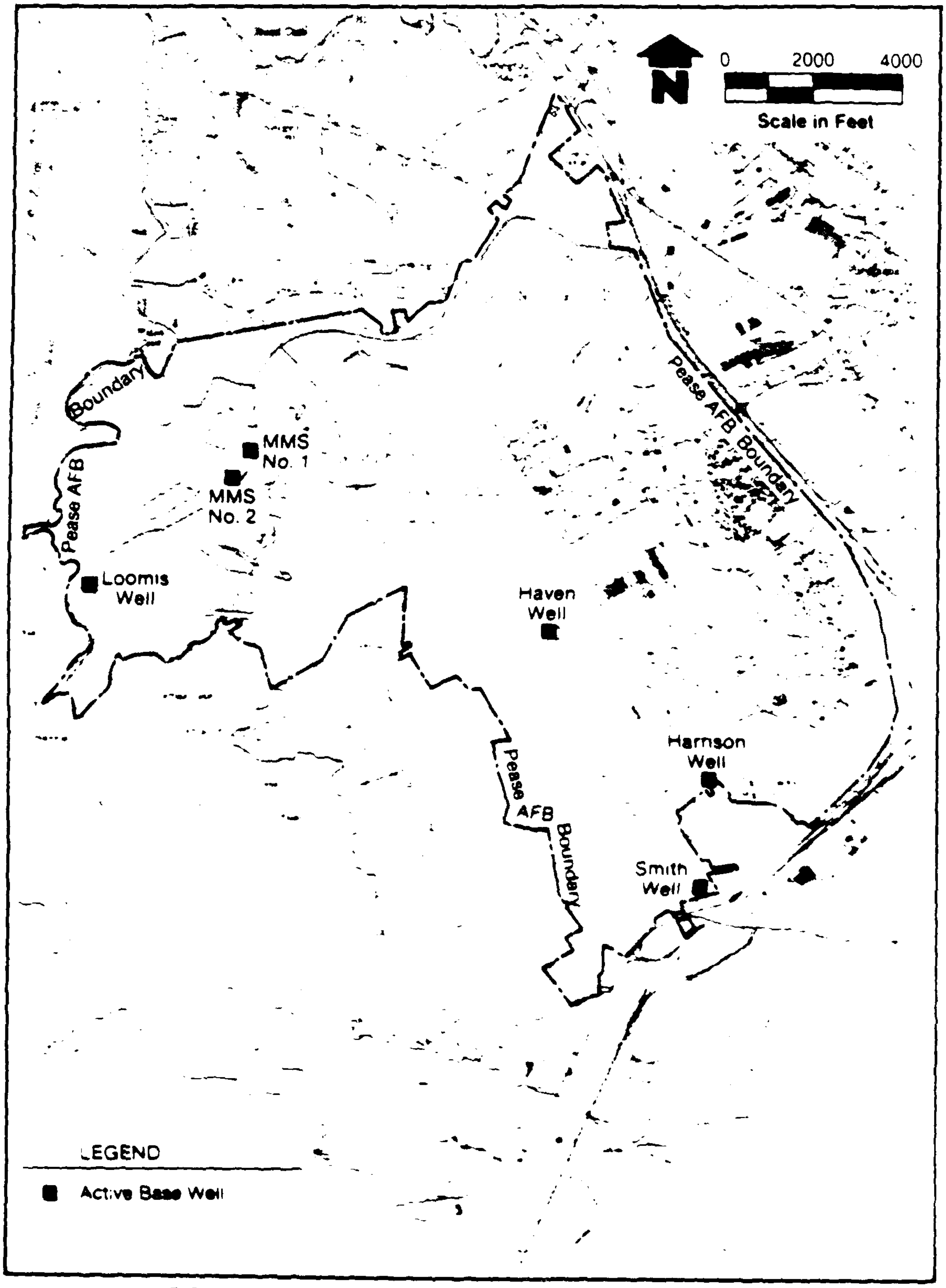


FIGURE 1-9 SITE MAP OF THE ACTIVE PRODUCTION WELLS

Table 1-4

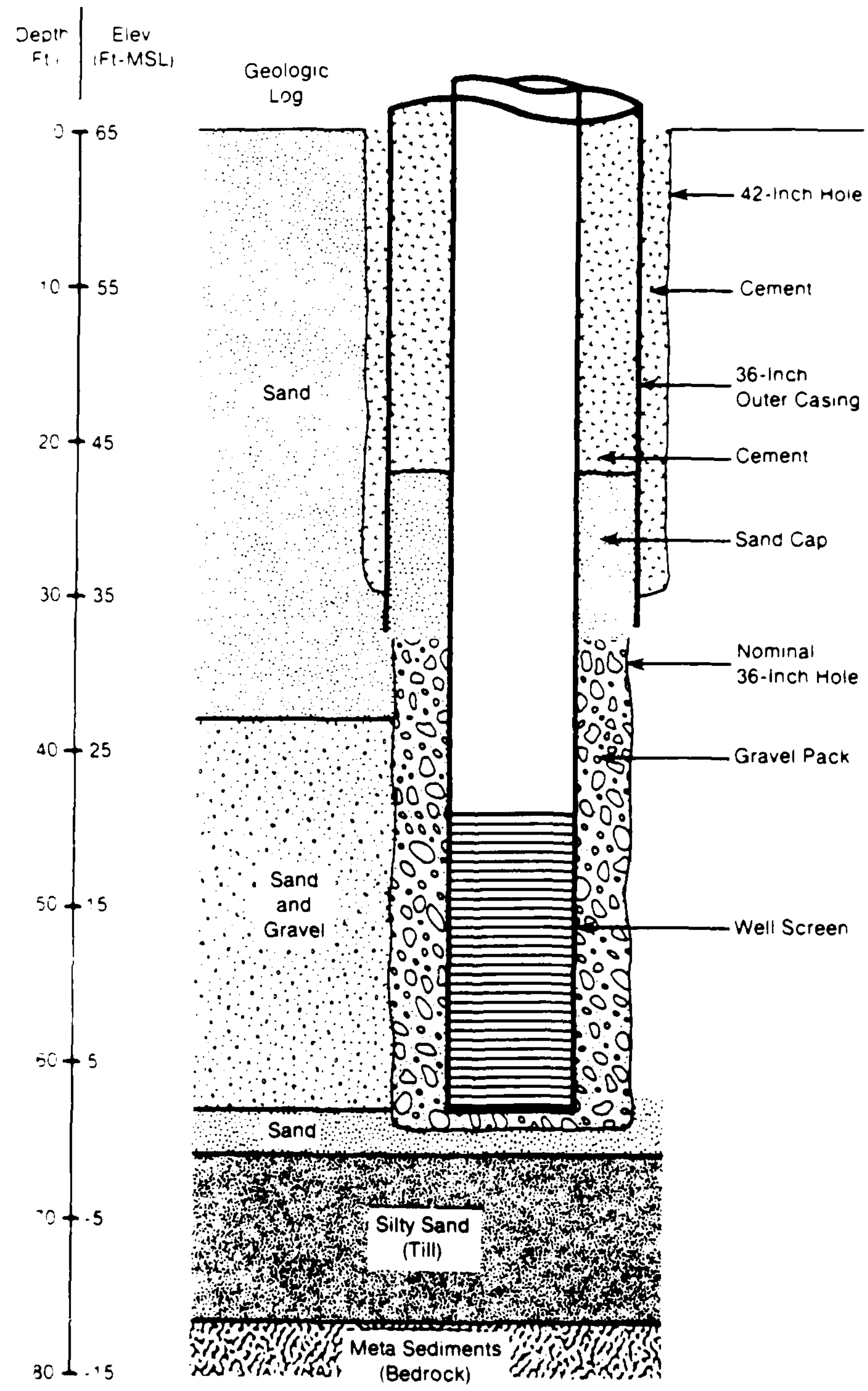
SUMMARY OF BASE SUPPLY WELL SPECIFICATIONS

Well Designation	Date of Construction	Diameter (in)	Depth (ft)	Screened Depth (ft)	Yield (gpm)	Drawdown (ft)	Aquifer Materials
Haven	1955	24	66	51-66	800	13.7	Ice Contact Deposits
Smith	1958	18	67	45-67	495	6	Ice Contact Deposits
Harrison	1957	12	46	31-46	225	15.5	Ice Contact Deposits
MMS No. 1	1956	6	130	Not Screened	28	60	Bedrock
MMS. No. 2	1955	6	170	Not Screened	29	44	Bedrock
Loomis	Pre-1956[a]	4	300	Not Screened	15	--	Bedrock

[a] This well was in existence prior to construction of the base.

-- Data unavailable

Source: Phase I Report, 1984



Source Layne-New England Co

FIGURE 1-10 GEOLOGIC LOG AND WELL CONSTRUCTION DETAIL FOR THE SMITH WELL.

[illegible] Storage Area [illegible] (MSA)

[illegible] streams and east [illegible]

[illegible] History and Description of Site [illegible] Construction Rubble Dump No. [illegible] (CRD-1)

[illegible] also borders the [illegible] to the west (Figure [illegible]).

Operated since the late 19[illegible]s, the site has been used primarily for the disposal of inert construction rubble such as concrete, pavement, tree stumps, and similar materials. According to the Phase I Report, waste solvents containing TCE may have been disposed of here during 1958 and 19[illegible] in 5-gallon cans at a rate of [illegible] gallons per month. Currently, part of the site is used as a gravel borrow area.

The area surrounding CRD-1 is part of a glacial kame plain and, as such, is flat; however, the topography drops off steeply toward Peverly Brook on the western side of the site. Much of the gravel material around the site has been removed by an on-going gravel mining operation.

1.3.3.8 Evaluation Zone 5

1.3.3.8.1 History and Description of Site 6: Landfill No. 6 (LF-6)

Landfill No. 6 is located in Zone 5 (Figure 1-13), in the southeastern part of the base, directly south of Facility 94. It is approximately seven acres in size.

Operated from 1972 to 1974 in a trench and fill mode (similar to other base landfills), the site received construction rubble debris, domestic solid wastes, waste solvents, and paint strippers and thinners. TCE-contaminated materials are not suspected to be present here since TCE was not commonly used at the base during the period of operation of Landfill No. 6.

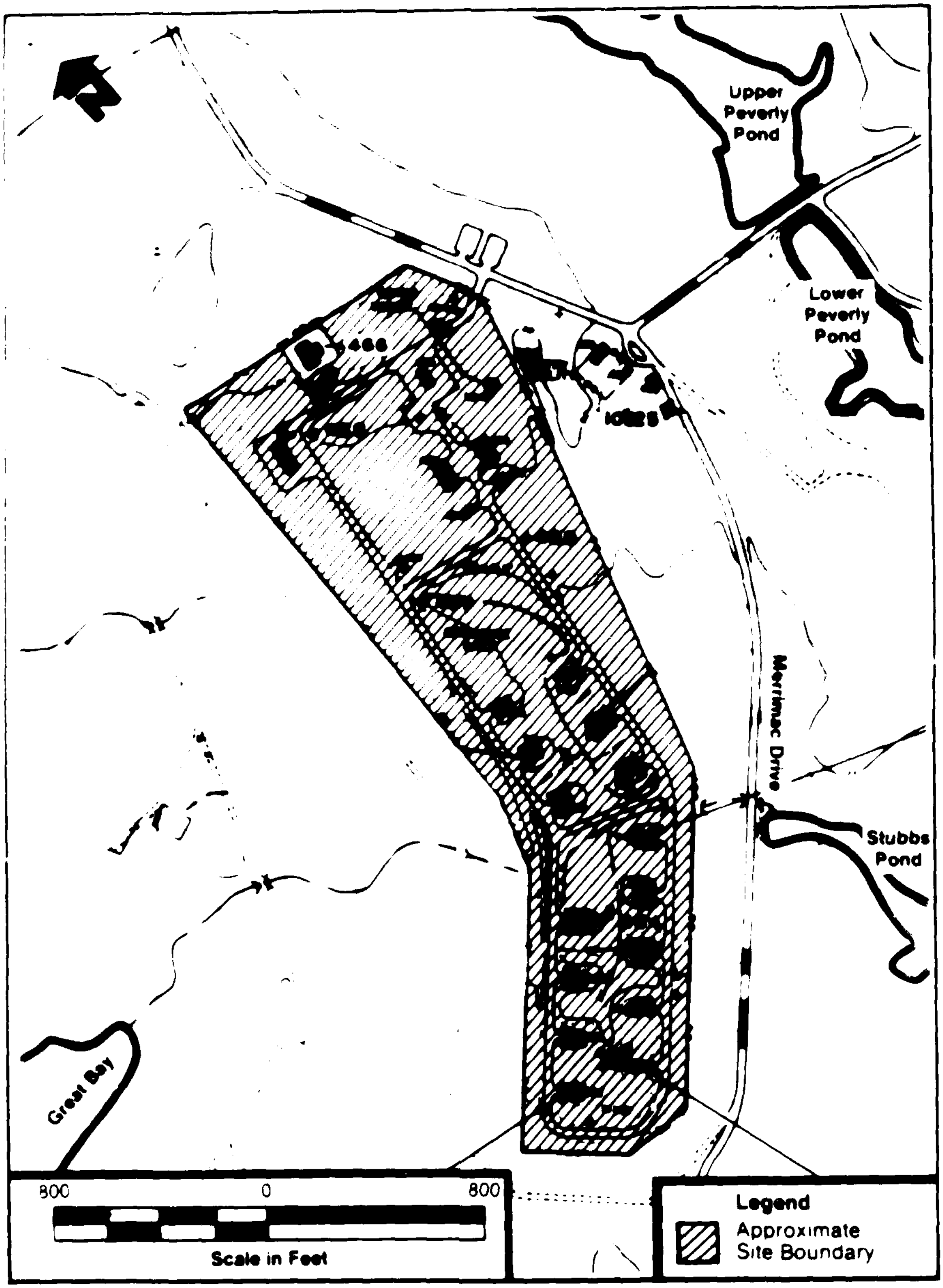


FIGURE 1-11 SITE MAP FOR THE MUNITIONS STORAGE AREA

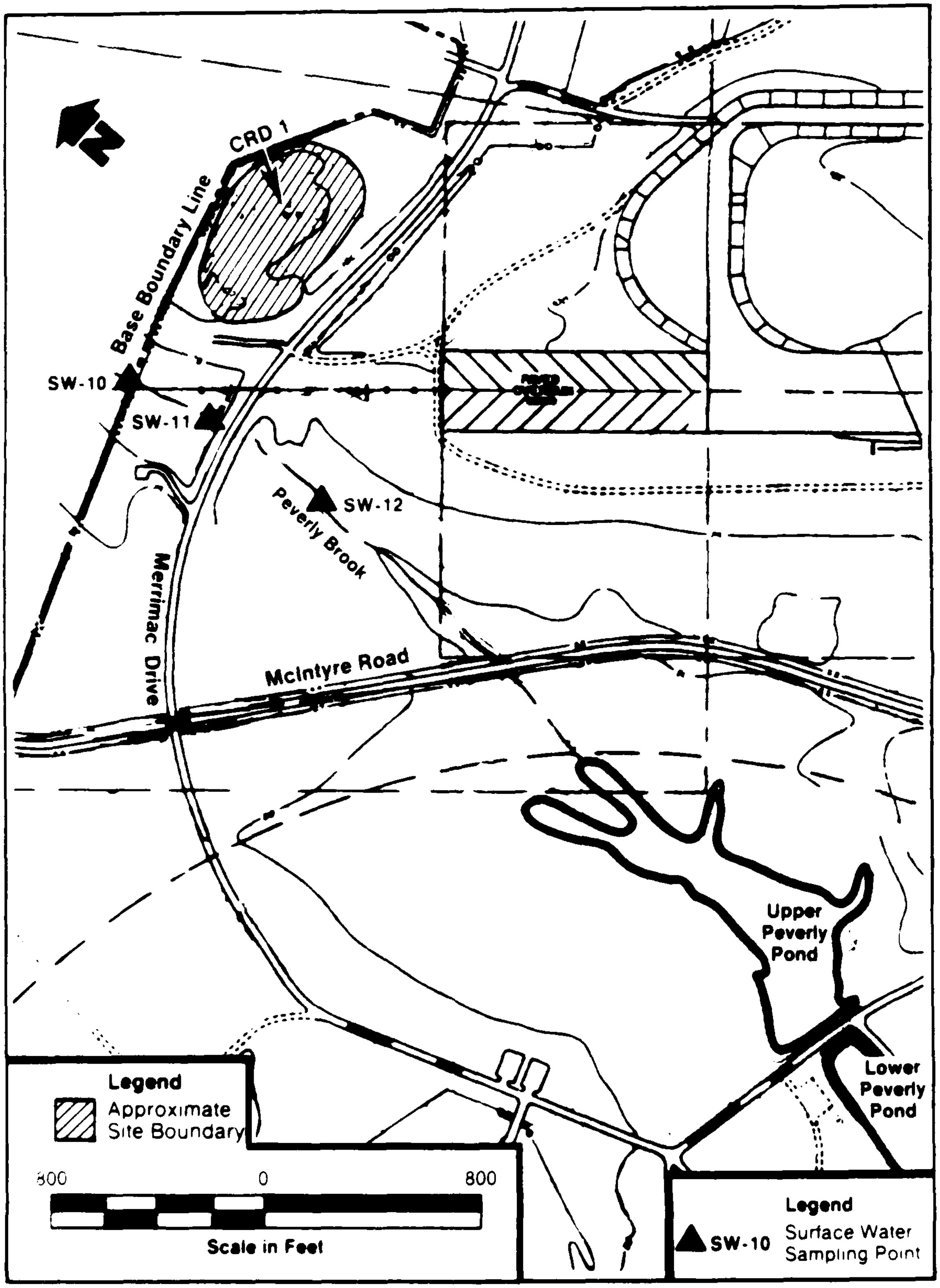


FIGURE 1-12 SITE MAP OF THE CONSTRUCTION RUBBLE - DUMP NO. 1

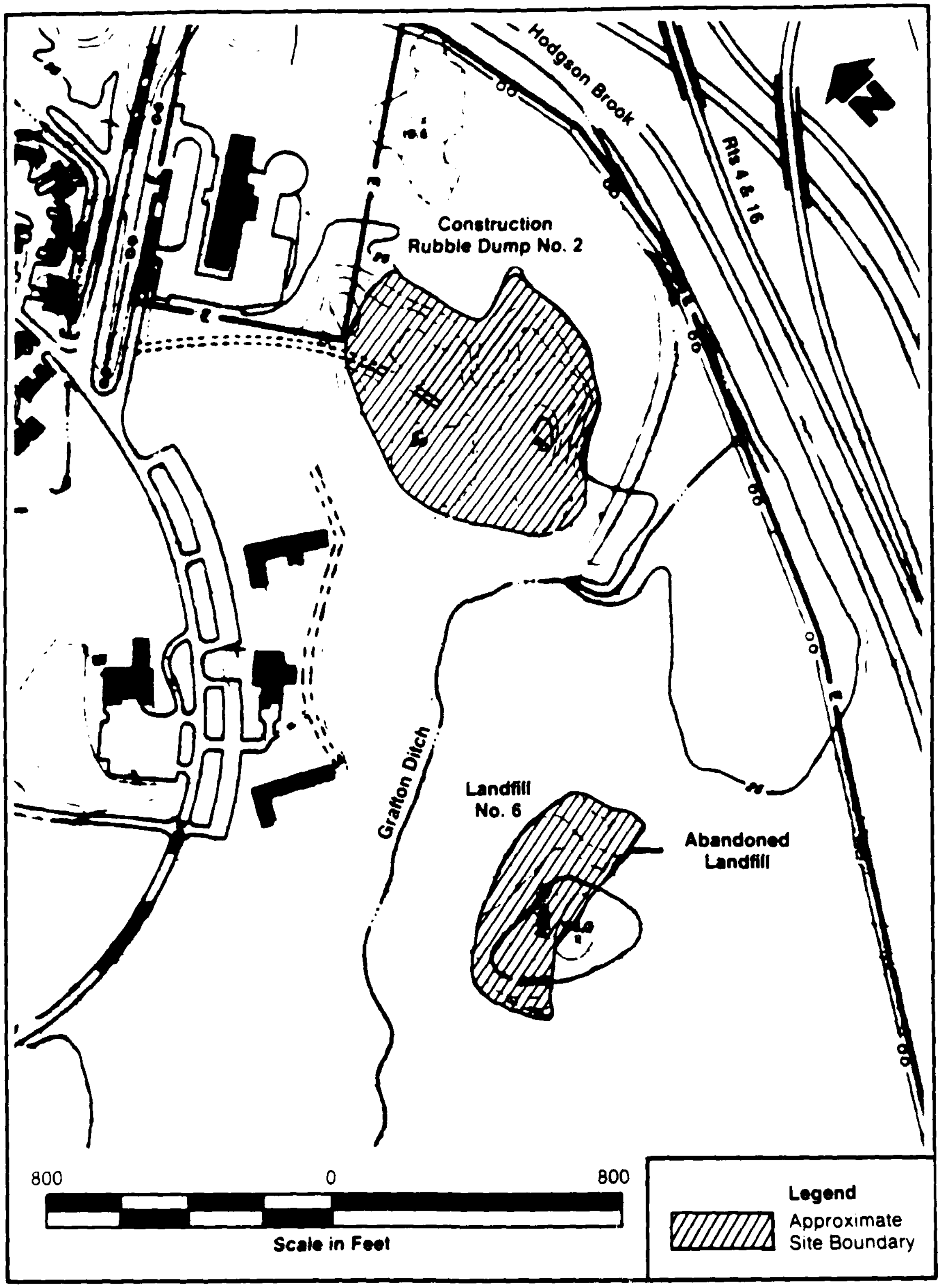


FIGURE 1-13 SITE MAP OF LANDFILL NO. 6 AND CONSTRUCTION RUBBLE DUMP NO. 2

The area is bordered along the east and south by shrub swamps, wetlands, and wooded areas. The topography is flat along the eastern boundary, rising to the west toward the site which is located on a topographic high. Grafton Ditch flows between LF-6 and CRD-2 toward its confluence with Hodgson Brook. The 1956 USGS 7.5 minute Portsmouth Quadrangle topographic map shows a small pond located to the north and west of the sites; the pond has been filled and currently, this area is primarily wooded with shrub swamps.

1.3.3.8.2 <u>History and Description of Site 17: Construction Rubble Dump No. 2 (CRD-2)</u>

Site 17 is located in Zone 5 adjacent to Site 6 (Figure 1-13). No hazardous substances were reported to have been disposed of here; however, during the Phase II presurvey site visit, drums were visible in the debris. Also a stream flowing through the site was affected by a blue-green algal growth. The site is currently receiving asphalt and concrete rubble, as well as gravel borrow.

1.3.3.8.3 <u>History and Description of Site 10: Leaded Fuel Tank Sludge Disposal Site (LFTS)</u>

The location of Site 10 is shown in Figure 1-14. It is located directly southwest of the TVOR Facility (Building 10804). The area is characterized by a relatively flat ground surface, tall grasses, and few small trees.

Site 10 was used from the late 1950's to mid 1970's for the disposal of sludges cleaned from the large AVGAS tanks located in the Bulk Fuels Storage Area. The use of AVGAS was discontinued in 1978. Before this, the tanks were inspected every 3 years and cleaned as necessary. Sludge cleaned from the tanks consisted of rust, water, residual fuel and fuel sludge, and material derived from sandblasting the tank interiors. Approximately 50 gallons of sludge were generated per tank cleaning. In early years, this sludge was drummed and buried at Site 10. In subsequent years, it was spread on the ground surface and allowed to weather as reported in the Phase I Report (1984).

1.3.3.9 <u>Evaluation Zone 6</u>

1.3.3.9.1 <u>History and Description of Site 11, FMS Equipment Cleaning Site (FMS)</u>

Site 11, the FMS Equipment Cleaning Site (FMS), is located in Zone 6 (Figure 1-15). Prior to 1971, this site was used

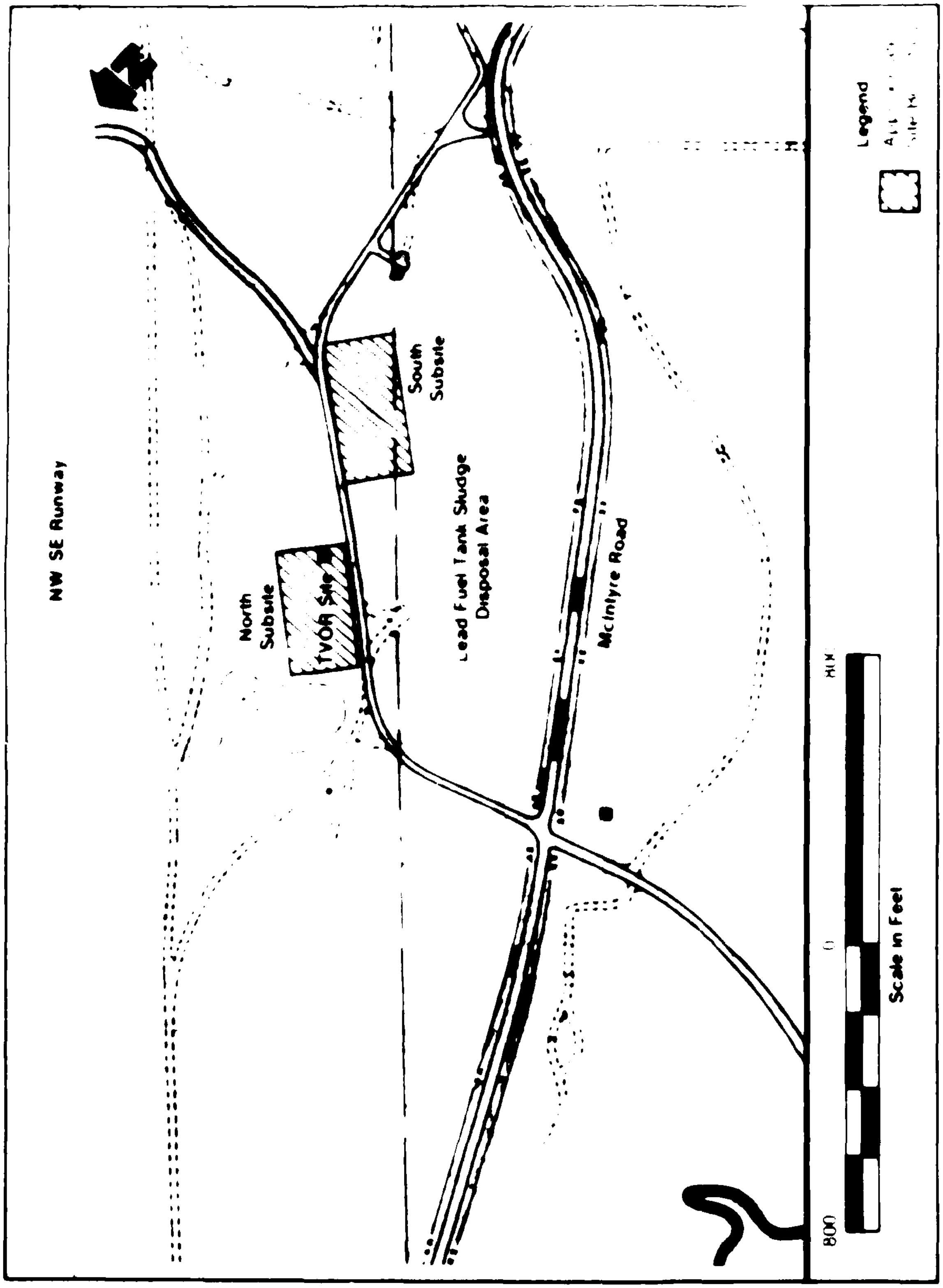


FIGURE 1-14 SITE MAP OF THE LEADED FUEL TANK SLUDGE DISPOSAL AREA

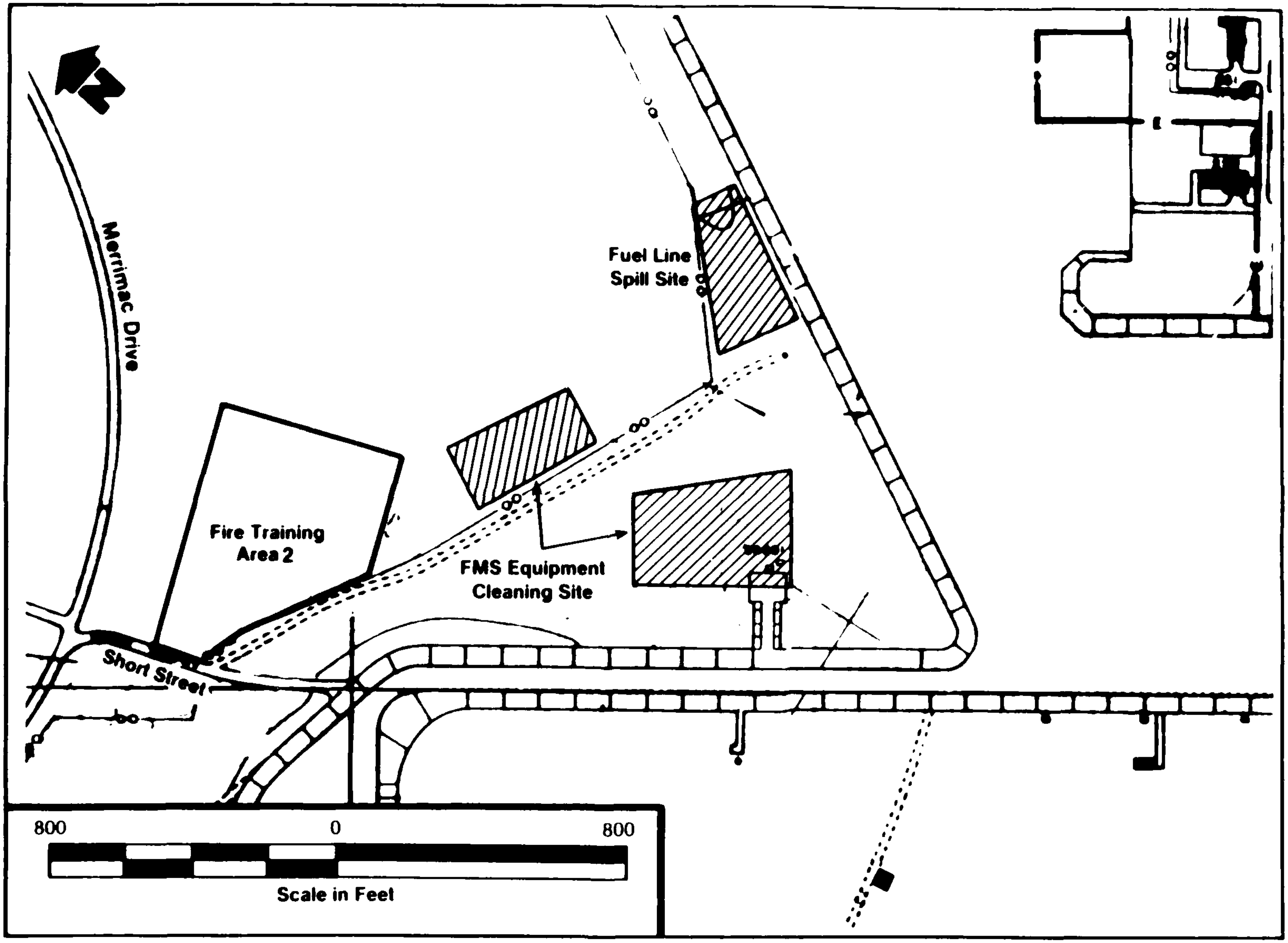


FIGURE 1-15 SITE MAP OF THE FMS EQUIPMENT CLEANING SITE/
FUEL LINE SPILL SITE

for the disposal of spent solvents used to clean new equipment of their protective cosmolene coating. Except for a 100-square foot area of stressed vegetation, there is no obvious evidence of adverse impacts as a result of past waste disposal practices.

Site 11 is situated on the flat to gently sloping area adjacent to the northeast aircraft parking apron and the northern end of taxiway D. Drainage from Site 11 is generally toward taxiway D to the southwest.

1.3.3.9.2 History and Description of Site 14, Fuel Line Spill Site (FLS)

In 1959, snow removal equipment ruptured a protruding vent line from the main underground fuel line, located northwest of Building 259 in a grass area adjacent to the northern perimeter of the aircraft parking apron (Figure 1-15). The resulting fuel loss was estimated to be at least 10,000 gallons. Most of the fuel reportedly either evaporated or was flushed with water into the storm drainage system (Phase I Report, 1984).

Drainage from Site 14 is to the northeast toward Flagstone Brook. Although no visual evidence of a major spill was apparent at this site, small patches of stressed vegetation along the parking apron were noted. These were evaluated during the course of the Phase II investigation.

1.4 CONTAMINATION PROFILE

Historically most of the wastes containing hazardous materials have been generated at Pease AFB by industrial aircraft maintenance or overhaul missions. Waste fuels and oils from normal base operations, and waste solvents from cleaning and painting operations are the primary wastes of concern. Leaded fuel sludges from storage tanks or tank cleaning operations also were generated in the past in relatively small quantities (approximately 50 gallons every three years).

From 1953 through 1971, an unknown quantity of industrial wastes was disposed of at each of six base landfills. Some potentially hazardous wastes were allegedly disposed of at each of two construction rubble dumps. In addition, unknown quantities of waste fuels, oils, and solvents were allowed to soak into the soil prior to and during fire department training exercises at two fire training areas.

Table 1-1 provides an historical summary of activities at the six landfills and two confirmed fire training areas. Disposal of leaded fuel sludge wastes reportedly took place from the late 1950's through the mid-1970's at a site near the TVOR site (Building 10804). Other possible sources of contamination include: a major fuel spill on the northeast aircraft parking apron in 1959; fuel leaks of varying quantities at the Bulk Fuel Storage Area; and leaking underground storage tanks and waste disposal practices in the flightline and industrial shop areas.

In 1977, complaints of odors and tastes in the base drinking water prompted an investigation described below (Subsection 1.5) which revealed contamination of groundwater by trichloroethylene (TCE) and four other volatile organic compounds. To date, the exact source or sources of these contaminants have not been identified; however, several potential sources have been considered, including the base storm drain system, buried waste TCE tanks in the shop area and activities at the Fire Department Training Area No. 2.

Based on the Pease AFB Phase I Records Search, the key chemical parameters of potential concern are: volatile organic compounds (VOC), pesticides, phenols, cyanide, oils and greases, and selected metals. To develop an initial determination of the extent to which past operational, storage, and disposal practices have adversely impacted the environment, soils, sediments, groundwater, and surface water in and around the various sites have been sampled and analyzed. Due to the number of sites to be evaluated, and in an effort to make the initial IRP evaluations more cost-effective, the Air Force selected a limited number of analytical indicator parameters, such as Total Organic Carbon (TOC), Total Organic Halogens (TOX), and selected other parameters. The details of the field work accomplished are described in Section 3 of this report.

1.5 FACTORS OF CONCERN

Several factors influence the potential for environmental impact of the specific sites identified for investigation in Phase II. These factors influenced the design of the scope of work, and the reader should be aware of them in reviewing the methods and evaluating the results of this investigation.

1.5.1 Existing On-Base Groundwater Contamination

Taste and odor problems in the base drinking water supply were first noted in 1977. Locations of production wells affected are shown on Figure 1-16. These complaints

WESTON

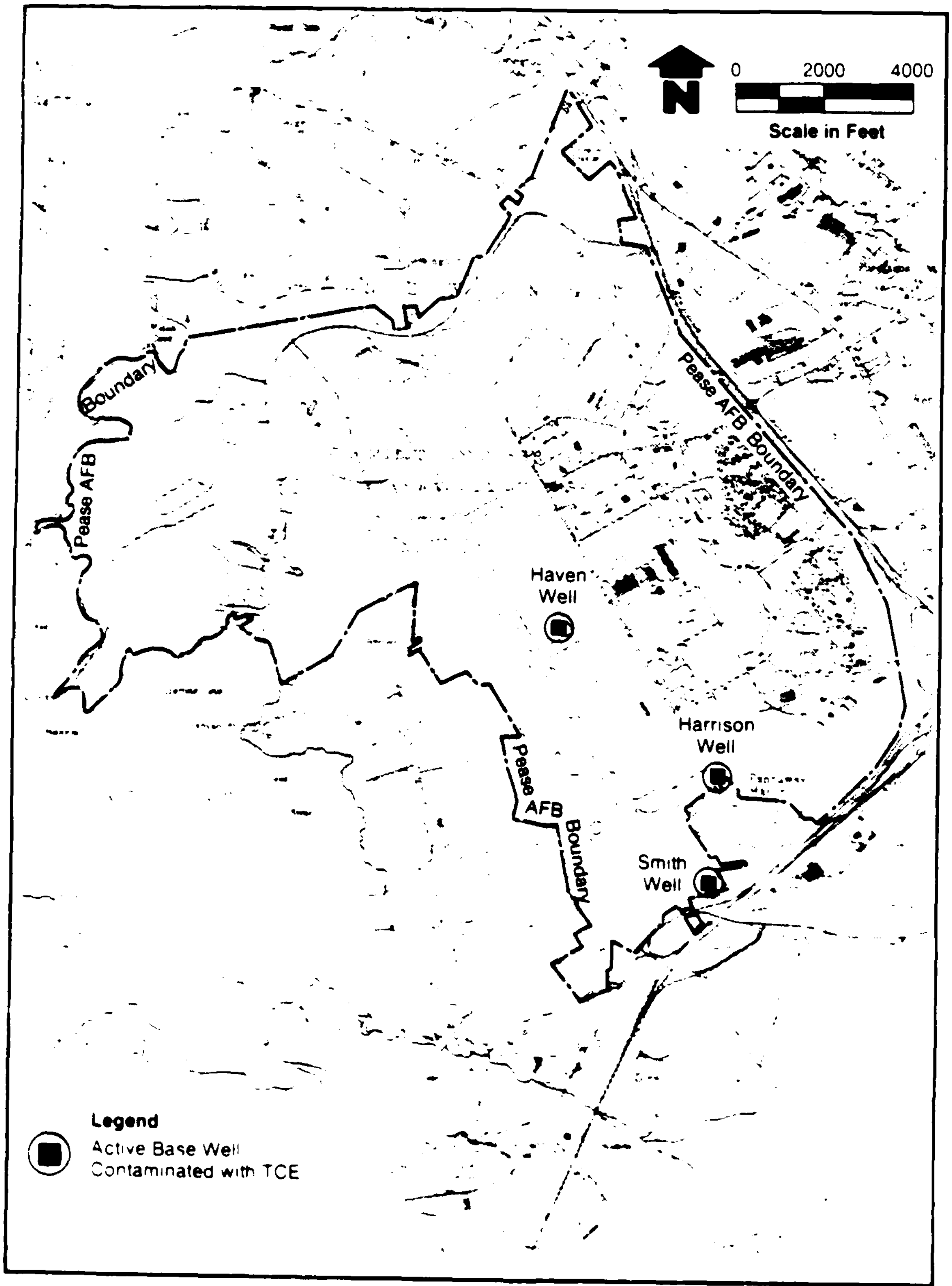


FIGURE 1-16 PRODUCTION WELLS WITH HISTORIC TRICHLOROETHYLENE CONTAMINATION

prompted two parallel investigations, one by the U.S. Geological Survey (USGS) to determine the hydrogeologic setting and the extent of contamination (Bradley, 1982), and the other by the USAFOEHL to determine past usage of TCE on base and potential sources of groundwater contamination (Pontier and Christensen, 1977).

The USGS study concluded that the minimum zone of groundwater contamination included 250 acres in the vicinity of the Haven well in the industrial shop/parking apron area. Based on test hole sample results, levels of TCE in groundwater throughout the area were found to be on the order of 150 ppb (Bradley, 1982,). The USAFOEHL study concluded that large volumes of TCE had been used at Pease AFB prior to 1973, and that usage was particularly heavy during the period from 1956 to 1966 when B-47 aircraft were stationed at the base. No single source of TCE was identified in either investigation, although the following sites were considered as probable contributing sources:

- Exfiltration from the storm drainage system which serves the flightline industrial shops, parking apron, and runway areas. The main 108-inch storm drain passes through the Haven well area.

- Underground collection tanks for waste TCE at Buildings 113 and 244.

- Fire Department Training Area No. 2 (FDTA-2, Site 8), which is located upgradient from the Haven well: mixed POL and solvent wastes were dumped and burned at the site.

The concentrations of TCE in the base supply wells have decreased since 1977, and are generally below 10 ppb at the present time. This indicates that either the principal source(s) are no longer actively contributing significant quantities of TCE to groundwater, or that groundwater flow through the ice-contact deposits is sufficient to significantly dilute current contributions. The main base supply wells are constructed in the ice-contact deposits, the most permeable aquifer materials in the area. Both recharge rates and contaminant travel times are rapid in these materials. For this reason, the supply wells remain highly vulnerable to potential sources of contamination which may become active contributors of contaminants to groundwater.

1.5.2 Off-Base Groundwater Resources

Groundwater is withdrawn in areas immediately adjacent to the base boundary for private drinking water supplies. In particular, several residences in Newington outside the northern base boundary depend on private supply wells for drinking water. Additionally, there are some industrial and public water supply wells remotely located south of the base boundary in the City of Portsmouth. These supplies may be potentially threatened by groundwater contamination originating within the area of Pease AFB, although the degree of risk varies depending on the nature of the potential source and the environmental setting. Considerable emphasis in this investigation has been placed on defining source areas and environmental conditions, such as soil type, aquifer materials and permeability, and direction of groundwater flow beneath each site, to further evaluate the potential for contaminant migration from each site via the groundwater medium.

1.5.3 Surface Water Resources

The other most likely medium besides groundwater for contaminant migration at Pease AFB is surface water. Water quality in base ditches and streams may be affected by contributions from two sources: direct surface discharges from storm drains, and groundwater discharge from shallow groundwater flow zones; both sources could potentially be contributing contaminants to the surface drainage system. Surface water bodies (including Upper and Lower Peverly Ponds), used for recreational purposes both on and off-base, are potentially threatened by contaminants carried in surface streams. The ultimate surface water receptors for Pease AFB are Great and Little Bays and the Piscataqua River, an extensive tidal and riverine estuary used for recreational purposes and shellfish harvesting.

1.6 PROJECT TEAM

The Phase II Stage 1 Confirmation Study at Pease AFB was conducted by staff personnel of ROY F. WESTON, INC., and was managed through WESTON's regional office in Concord, New Hampshire.

WESTON

1.6.1 WESTON Personnel

The following personnel served lead functions in this project:

PETER J. MARKS, PROGRAM MANAGER

Corporate Vice President, M.S. in Environmental Science, 18 years experience in laboratory analysis and applied environmental sciences.

FREDERICK BOPP, III, PH.D., P.G., CONTRACT MANAGER (Until April 1985)

Manager of the Geosciences Department, Doctor of Philosophy (Ph.D.) in Geology and Geochemistry. Registered Professional Geologist (P.G.), over 8 years experience in hydrogeology and applied geological sciences.

KATHERINE A. SHEEDY, P.G., CONTRACT MANAGER (After April 1985)

M.S. in Geology, Registered Professional Geologist, 11 years experience in hydrogeology and environmental geology.

RICHARD L. KRAYBILL, P.G., PROJECT MANAGER

Regional Geologist for New England, M.S. in Geological Sciences, over 14 years experience in applied geology and hydrogeology.

WALTER M. LEIS, P.G., GEOTECHNICAL QUALITY ASSURANCE OFFICER

Corporate Vice President, M.S. in Geological Sciences, Registered Professional Geologist, over 10 years experience in hydrogeology and applied geological sciences.

EARL HANSEN, PH.D., LABORATORY MANAGER

Ph.D. in Chemistry, 13 years experience in environmental consulting and project management; over 5 years of laboratory management and QA/QC experience related to inorganic and organic analyses of soil, water, air and waste sludges.

CARTER NULTON, Ph.D., MANAGER OF ORGANIC LABORATORY

Ph.D. in Biochemistry, 14 years analytical experience in organic analyses using GC and GC/MS techniques; 7 years environmental chemistry consulting experience.

GLENN SMART, PROJECT GEOLOGIST

Regional geohydrologist for New England, B.S. in Hydrology with over 8 years experience in water resource and hazardous waste site investigations. Field work conducted since 1984.

Professional profiles of these key personnel, as well as other project personnel, are contained in Appendix C.

[illegible] Subcontractors

[illegible] pits were excavated by personnel of Robinson Construction Company of North Hampton, New Hampshire. All well drilling and installation was performed by Contec, Inc., of [illegible], New Hampshire.

[illegible] REPORT ORGANIZATION

[illegible] of the Pease AFB Phase II Stage 1 report is [illegible] sections as follows:

Section 1: An introduction to the Installation Restoration Program and brief histories of the base and activities at the sites of interest.

Section 2: A discussion of the environmental setting of the base and surrounding areas.

Section 3: A description of the field activities performed.

Section 4: A discussion of the results and conclusions drawn from the field activities and laboratory analytical data.

[illegible] A review of available site-specific remedial and investigative alternatives.

[illegible] Recommendations for future investigation [illegible].

Volume II of the Phase II Stage 1 report contains the following thirteen Appendices:

Appendix A:	Acronyms, Definitions, Nomenclature, and Units of Measurement
Appendix B:	Task Order, Statement of Work
Appendix C:	Well Construction Summaries, Boring Logs and Hydraulic Conductivity Test Results
Appendix D:	Well Numbering System
Appendix E:	Field Raw Data
Appendix F.1:	Sampling and Quality Assurance Plan
Appendix F.2:	Analytical Methods and Required Detection Limits
Appendix G:	WESTON Chain-of-Custody Forms
Appendix H:	Laboratory Analytical Reports
Appendix I:	Federal and State Water Quality and Human Health Standards Applicable in the State of New Hampshire
Appendix J:	References
Appendix K:	Professional Profiles of Key Personnel
Appendix L:	US Air Force Form 2752
Appendix M:	Site Safety Plan.

WESTON

SECTION 2

ENVIRONMENTAL SETTING

2.1 CLIMATE

Pease AFB, situated in Rockingham County, New Hampshire, experiences a continental climate typical of the northern New England coast. Prevailing winds in the area are from the west. Frequent sea breezes off the Atlantic Ocean tend to modify continental-type temperatures (SCS, 1959). The mild summers have daytime highs typically reaching the upper 70's with nighttime lows in the upper 50's to low 60's (CH2M Hill, 1984). Summer highs of up to 100°F have occurred with 101°F being the recorded high. Winters are long and cold with daytime average highs reaching into the low to mid 30's and dropping to the upper teens at night. Subzero temperatures are not uncommon; the lowest recorded temperature at the base is -13°F (Phase I Report, 1984).

The mean annual total precipitation of 43.9 inches is spread relatively evenly throughout the year, varying from a mean monthly low of 2.7 inches in August to a high of 4.9 in November. Mean annual lake evaporation is approximately 25 inches per year, which results in an annual net precipitation of 19 inches (Phase I Report, 1984).

The major storms of record in this area are the occasional hurricanes that move up the coastline and the more frequent "northeasters," winter low-pressure areas that move north along the coast generating strong northeast winds bringing heavy precipitation and high tides. Table 2-1 summarizes the meteorological data for the area.

2.2 PHYSICAL GEOGRAPHY

Pease AFB is located in the seaboard lowlands section of the New England Physiographic Province. The region, characterized by smooth plains with low, rounded hills, is bordered on the east by the Atlantic Ocean and on the west by the New England upland section. The base (shown in Figure 2-1) is located in Rockingham County, between the City of Portsmouth and the Towns of Newington and Greenland, approximately in the center of a peninsula of land bordered on the west and north by Great and Little Bays and on the east by the Piscataqua River.

Table 2-1

METEOROLOGICAL DATA SUMMARY FOR PEASE AFB (1957-1979)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Temperature (°F)													
Mean Daily Maximum	32	33	42	54	65	75	80	78	70	60	48	35	56
Mean Daily Minimum	16	17	27	36	46	56	61	60	52	42	34	21	39
Mean Monthly	24	25	35	45	56	66	71	69	62	51	41	28	48
Extreme Maximum	61	60	78	91	99	95	101	100	94	87	75	64	101
Extreme Minimum	-13	-9	0	18	29	40	47	40	32	23	11	-9	-13
Precipitation (in)													
Mean Monthly	4.2	3.6	3.5	3.5	3.5	3.0	3.0	2.7	3.6	3.8	4.9	4.6	43.9
Monthly Maximum	12.3	6.3	6.2	11.1	6.7	6.2	5.1	7.2	8.1	12.1	12.4	10.1	12.4
Monthly Minimum	0.8	0.9	1.7	1.1	1.0	0.8	0.6	1.1	0.2	1.0	0.8	1.5	0.2
Mean Monthly Snowfall	18	19	14	2	T	0	0	0	0	T	3	18	74
Maximum Monthly Snowfall	44	61	30	9	T	0	0	0	0	2	13	38	61
Wind (kt)													
Mean	7	8	8	8	7	6	5	5	5	6	6	8	7
Prevailing Direction	W	W	W	W	W	W	W	W	W	W	W	W	W

Source: AWS Climatic Brief, Pease AFB, in: Phase I Report

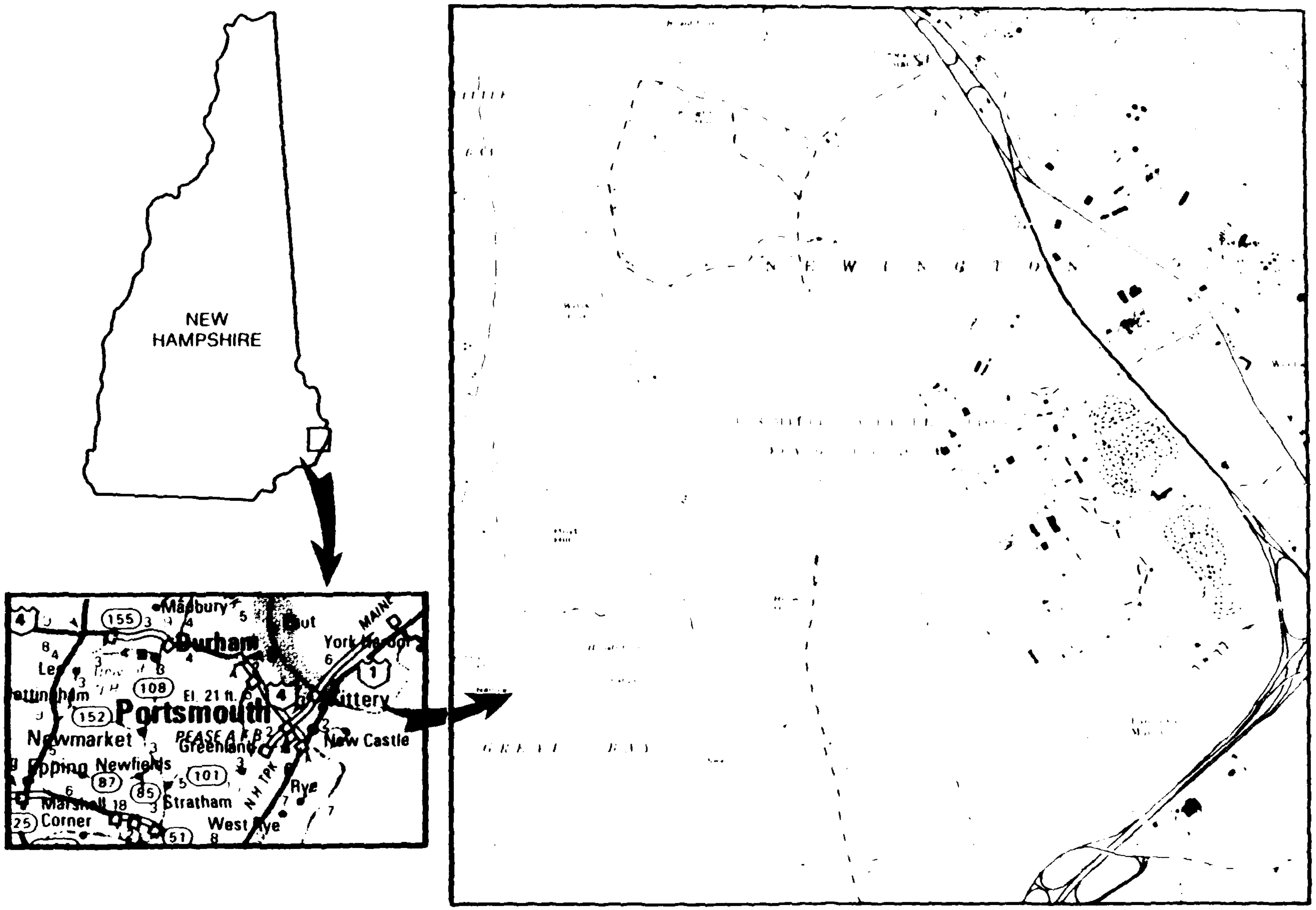


FIGURE 2-1 INDEX MAP OF PEASE AIR FORCE BASE

Elevations range from a high of 100+ feet National Geodetic Vertical Datum (NGVD) at the northwest end of the runway to sea level at Great Bay on the western base boundary. The natural glacially formed land surface has been extensively altered by construction of runway and support facilities. Much of the original undulating topography has been leveled, wetlands have been filled, and stream channels have been altered and confined to storm drain systems and culverts.

2.3 SURFACE DRAINAGE

The peninsula on which Pease AFB is located lies within the Piscataqua River drainage basin. The river drains approximately 1,020 square miles of southern Maine and southeastern New Hampshire. The Piscataqua River is a 13-mile tidal bay fed from the confluence of the Salmon Falls and Cocheco Rivers which enter from the north and northwest. It flows along the northeastern edge of the peninsula and discharges to the Atlantic Ocean.

Great and Little Bays, located west and north of the base, comprise a tidal estuary and cover over 10 square miles. They are fed from the Exeter River to the south, the Lamprey and Oyster Rivers to the west, and other minor tributaries. Little Bay drains to the Piscataqua River at the northern tip of the peninsula.

The Bays and the Piscataqua River are tidal in nature and are subject to the associated daily water-level fluctuations and to the flushing effects of tidal currents entering and exiting the estuaries on a twice daily basis. Surface drainage from the base is radial with the western and northern sections discharging to the Bay area, the eastern portion discharging toward the Piscataqua River, and the southern portion draining toward Great Bay to the southwest.

Construction of the runways, parking areas, support buildings, and base housing has resulted in major alterations in the natural flow regime. Storm water runoff is routed through storm drains, culverts, and drainage ditches (Figure 2-2). Most of the runoff from the runway, flightline shop area, and parking apron passes through an oil/water separator before being discharged to the west to McIntyre Brook and ultimately to Great Bay.

WESTON

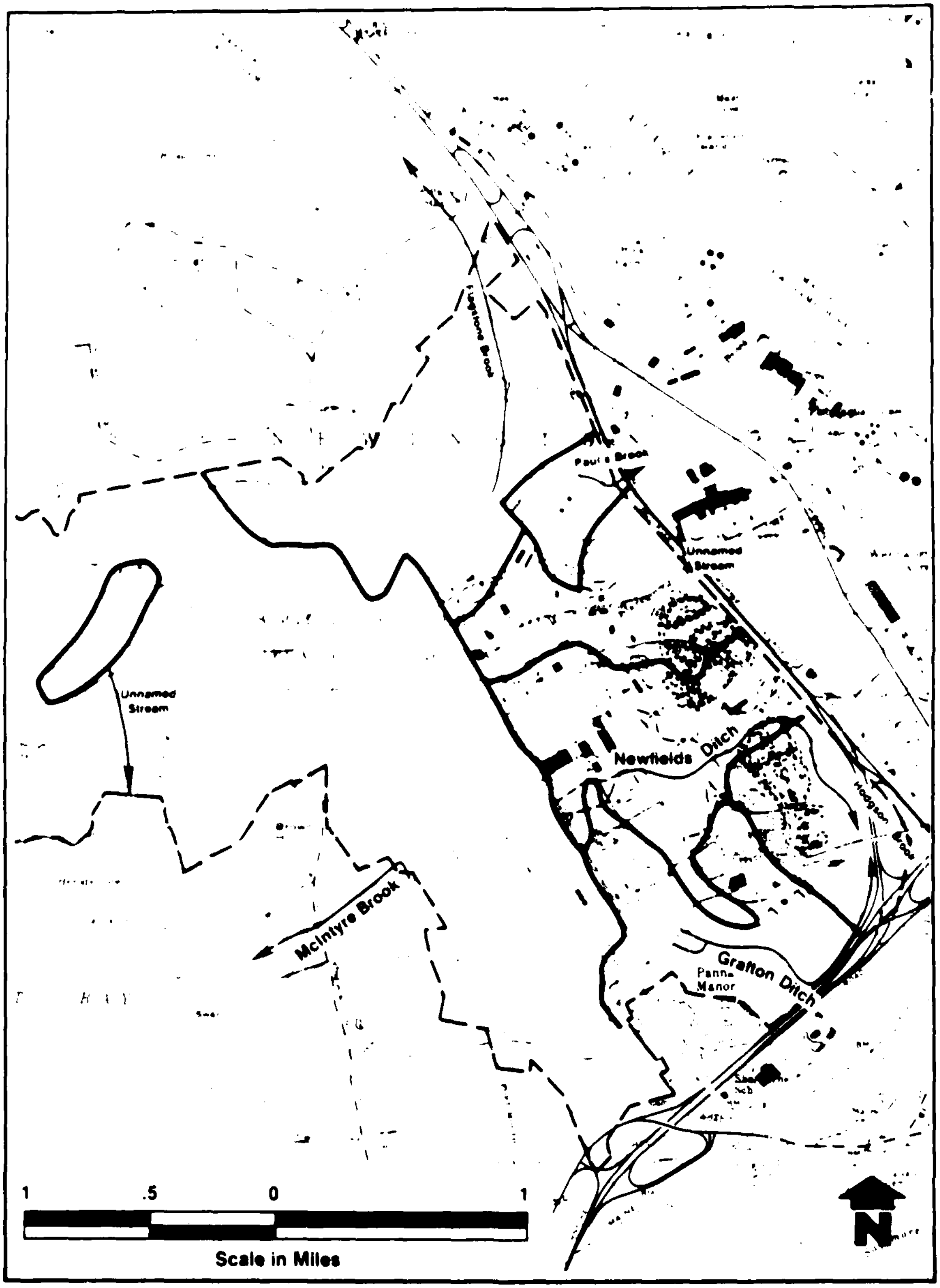


FIGURE 2-2 STORM DRAINAGE SYSTEM - PEASE AFB

2.4 SOILS

The soil associations at Pease AFB are numerous and varied, and reflect the complex geologic history of the region. Recent unpublished soil series maps, completed by the USDA Soil Conservation Service, show much of the base as being covered by "urban land" (developed land with disturbed soils). Previous work in the area (SCS, 1959) shows native soils in this area ranging from marine and glaciolacustrine derived silty clay loam associated with till and clay deposits to excessively drained glaciofluvially derived loamy sands associated with glacial or marsh and ice-contact deposits. Table 2-2 lists the soil permeabilities and average depth to water table for the soils found at the Phase II sites.

2.5 SURFICIAL GEOLOGY

Pease AFB is situated in the coastal lowlands of southeastern New Hampshire. During the Wisconsin Stage of the Pleistocene Epoch (approximately 10,000 to 15,000 years ago) the entire region was covered by a vast continental glacier. The ice sheet advanced southward, scouring existing surficial deposits from the bedrock and depositing new material in the form of glacial till and stratified drift. The glacial till is an unsorted, unstratified mixture of clay, silt, sand, and gravel, and occurs as either basal till (dense deposits smeared over the bedrock surface by the weight of the ice), or as ablation till (unsorted glacial debris entrained within the ice and deposited as the ice melted). Stratified drift is water-borne material deposited in well-sorted layers, often in contact with the glacial ice.

At Pease AFB, the advancing glacier deposited a thin, discontinuous layer of till over the bedrock. Subsequently, meltwater from the receding glacier laid down stratified drift as a flat-topped, coarse-grained deposit known as a kame plain. This kame plain, or ice-contact plain, exists today as a linear feature trending northwest and sloping at approximately 30 feet per mile toward the southeast. As the ice sheet melted, sea level rose, inundating low areas and forming shallow estuaries where marine clays were deposited and interfingered with deposits of till and stratified drift. When the massive weight of the ice was removed, the land surface began to rebound, rising to its current elevation. More recently, marsh deposits have been laid down in Great and Little Bays and streams have reworked glacial deposits producing the conditions found today. Figure 2-3 shows the approximate distribution of surficial materials on the base as previously mapped (Tuttle).

TABLE 2-2

PROPERTIES OF SOILS AT PHASE II FIELD
INVESTIGATION SITES PEASE AFB

Site	Soil Type	Percolation Rate (ft/day)	[illegible]	[illegible] Water Table (ft)
LF-1	Udorthents, Elmridge	2.8 to 11.3	4 [illegible]	[illegible]
LF-2	Pennichuck	1.1 to 2.8	[illegible]	[illegible]
LF-3	Udorthents, Shaker	2.8 to [illegible]	[illegible]	[illegible]
LF-4	Pennichuck	1.1 to 2.8	[illegible]	[illegible]
LF-5	Udorthents, Shaker Pennichuck	1.1 to 11.3	[illegible]	[illegible]
LF-6	Udorthents, Shaker	2.8 to 11.3	4 [illegible]	[illegible]
FDTA-1	Udorthents	*	4 [illegible]	*
FDTA-2	Udorthents	*	4 [illegible]	*
CRD 1	Borrow Pits	>11.3	*	[illegible]
LFTS	Hinckley	11.3 to 28.3	4 [illegible]	6
FMS	Hoosic	2.8 to 28.3	4 [illegible]	6
MSA	Udorthents	*	4 [illegible]	*
BFSA	Udorthents, Pennichack	1.1 to 2.8	[illegible] 4 [illegible]	6
FLS	Hoosic	11.3 to 28.3	4 [illegible]	6
IS/PA	Udorthents, Shaker, Pipestone	1.1 to 28.3	4 [illegible]	0 [illegible] to 6
CRD-2	Udorthents, Whatley	0.3 to 11.3	*	*

Source: US Soil Conservation Service open file
* Value not listed

Udorthents - Urban land and fill
Pennichack - Very fine sandy loam
Elmridge - Sandy loam
Shaker - Sandy loam
Borrow Pits - Sandy and gravel

Hinckley - [illegible]
Hoosic - [illegible]
Pipestone - [illegible]
Whatley - [illegible]

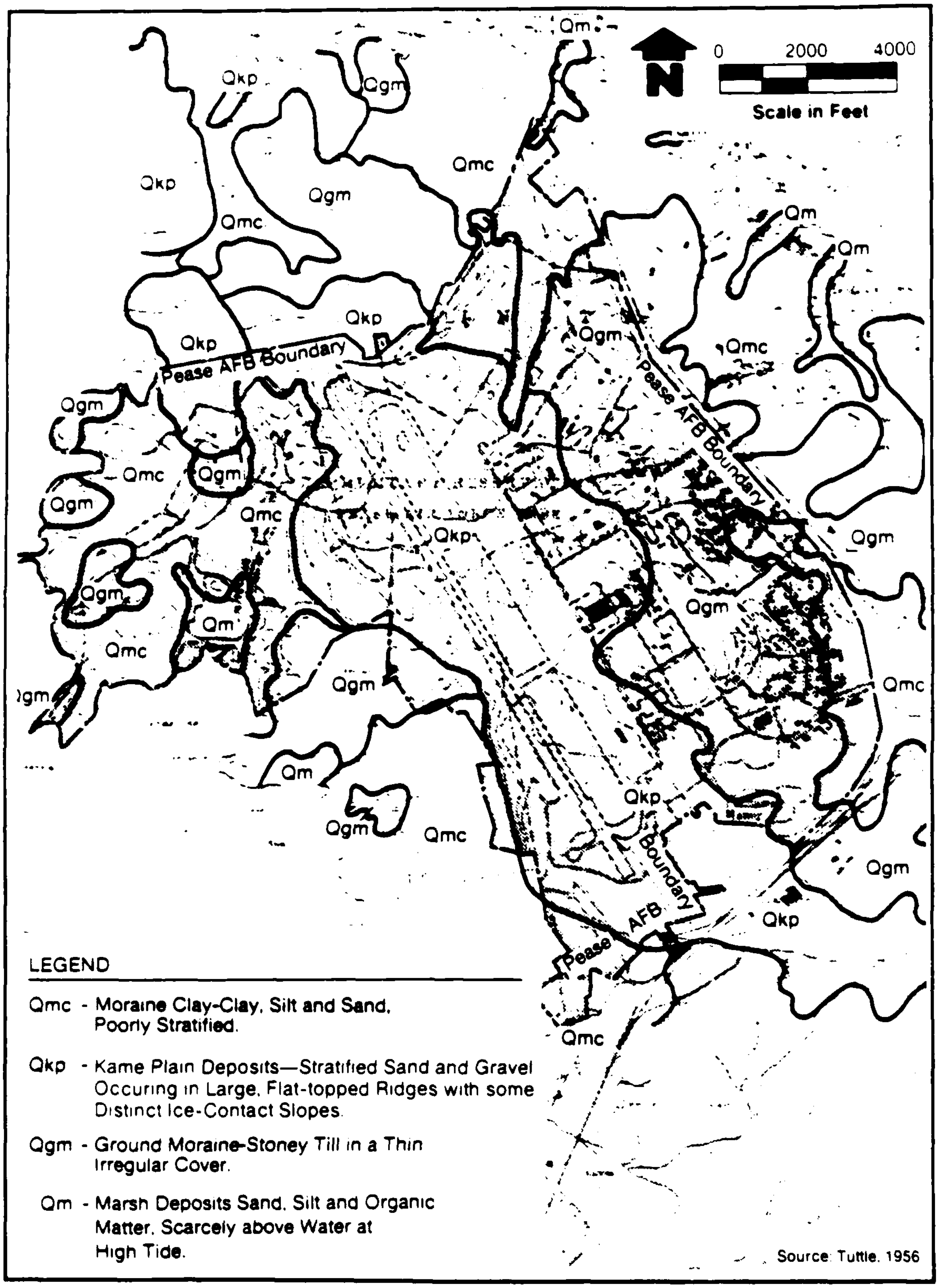


FIGURE 2-3 SURFICIAL GEOLOGIC MAP, PEASE AFB

2.6 BEDROCK GEOLOGY

Pease AFB is underlain by metasedimentary bedrock at depths ranging from 0 to over 100 feet. Bedrock beneath the flightline occurs at 55 to 80 feet below ground surface. The bedrock formations underlying Pease AFB are the Kittery and Eliot Formations (Figure 2-4). Billings (1980) placed the age of the formations at approximately 420 million years (Silurian Period); more recent data suggest that the rock may be pre-Silurian (Cotton, 1983, in: CH2M Hill, 1984). The two formations were mapped and described by Novotny (1969). He described the Eliot Formation as:

"dark gray slate; dark gray to dark green phyllite, commonly dolomitic; light to dark gray to black biotite schist, quartz biotite schist, and feldspathic quartz-biotite schist; massive, light gray to light gray-green, fine-grained quartzite, in part feldspathic, in part dolomitic; light gray-green to brown, fine- to medium-grained, lime-silicate rock, containing actinolite.

Novotny described the Kittery formation as follows:

"dark gray slate; dark gray-green to silvery gray phyllite; fine- to medium-grained, finely laminated to massive, poorly- to well-foliated quartz-biotite schist, biotite-sericite schist, and feldspathic quartz-biotite schist, commonly calcareous and actinolitic; light gray-green to dark gray, well-bedded to massive, fine-grained quartzite and feldspathic quartzite; thin-bedded to massive, medium-grained, light gray to light gray-green lime-silicate rock."

As mapped by Novotny (1969) the contact between the two formations essentially bisects the base from southwest to northeast (Figure 2-4). Figure 2-5 is a geologic cross-section drawn perpendicular to the contact.

Both bedrock formations are low to medium-grade metamorphic rocks that have been faulted and folded by as many as three mountain building episodes. Predominant bedrock structures in the region trend northeast-southwest (Figures 2-4 and 2-6), resulting from torsional, tensional, and compressional forces predominantly from the southeast. The Portsmouth Fault, a nearly vertical normal fault approximately two miles southeast of the base, trends northeast-southwest and forms the boundary between the Silurian formations described above and younger Ordovician-age metasedimentary and metavolcanic rocks (Novotny, 1969).

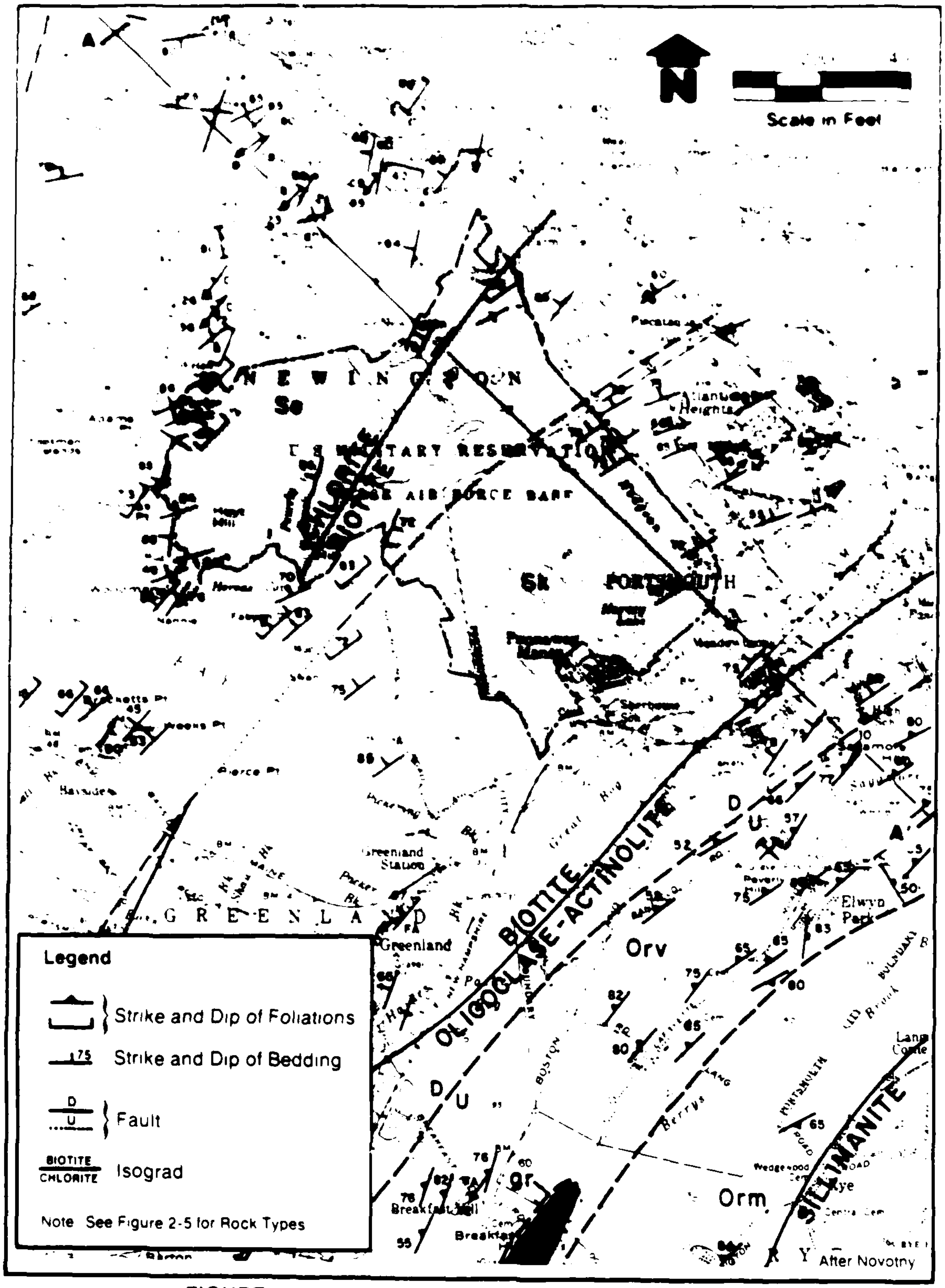
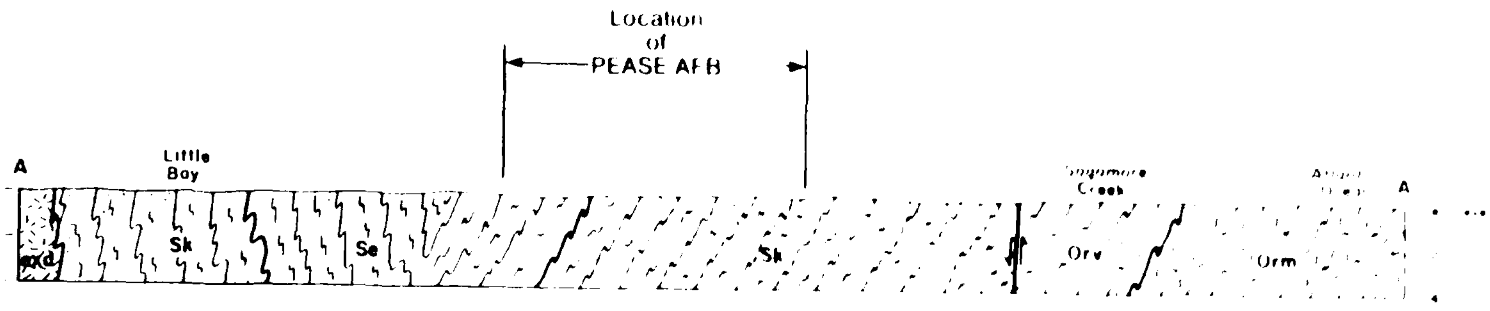


FIGURE 2-4 BEDROCK GEOLOGIC MAP - PEASE AFB



Legend

exd. - Exeter Diorite

Se - Eliot Formation

Sk - Kittery Formation

Orv - Rye Formation-Upper Metavolcanic

Orm - Rye Formation-Lower Metasedimentary

Source: New Hampshire Dept. of Resources and Economic Development

Note: See Figure 2-4 for Section Location

FIGURE 2-5 BEDROCK GEOLOGIC CROSS SECTION AA'

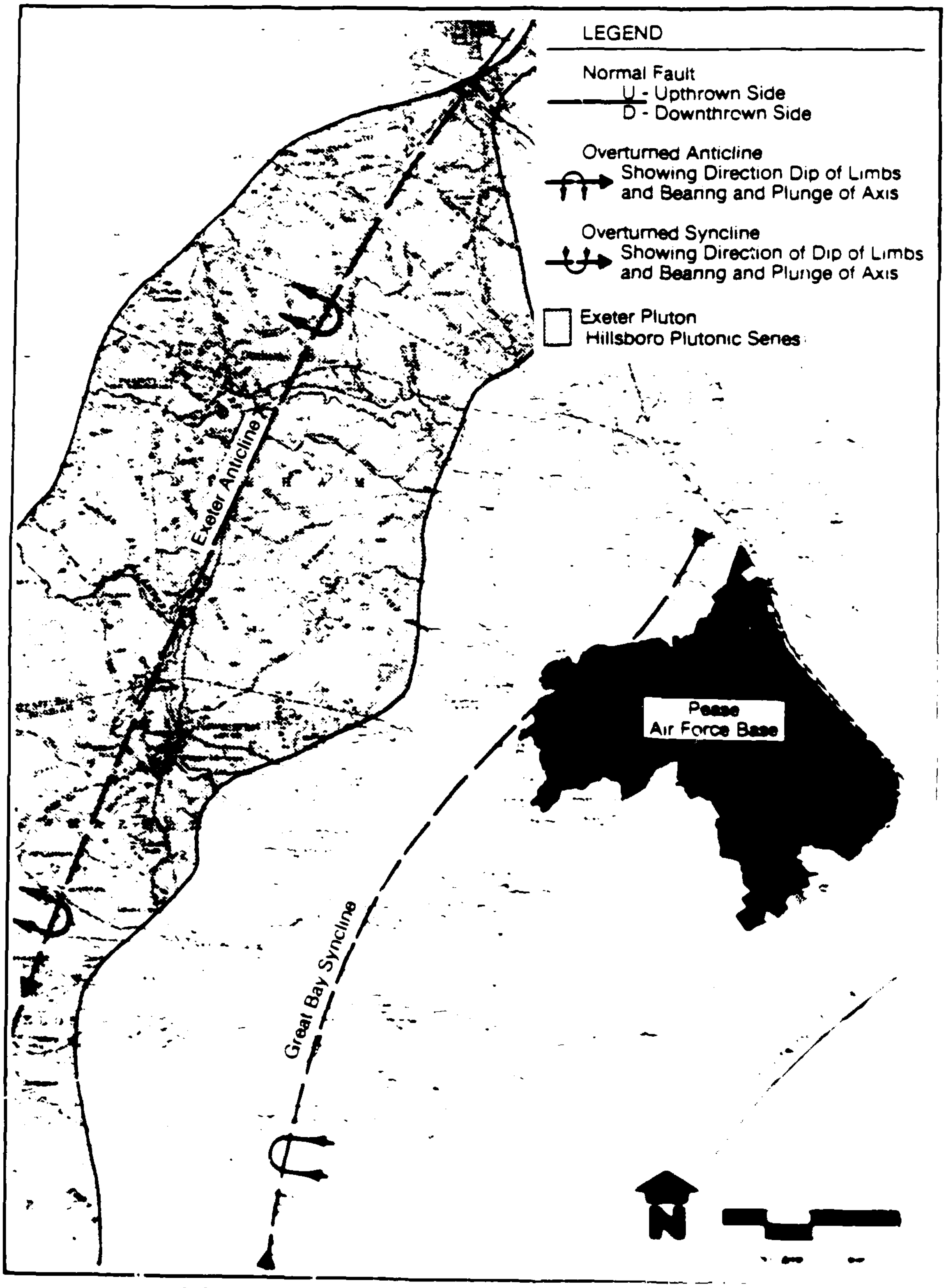
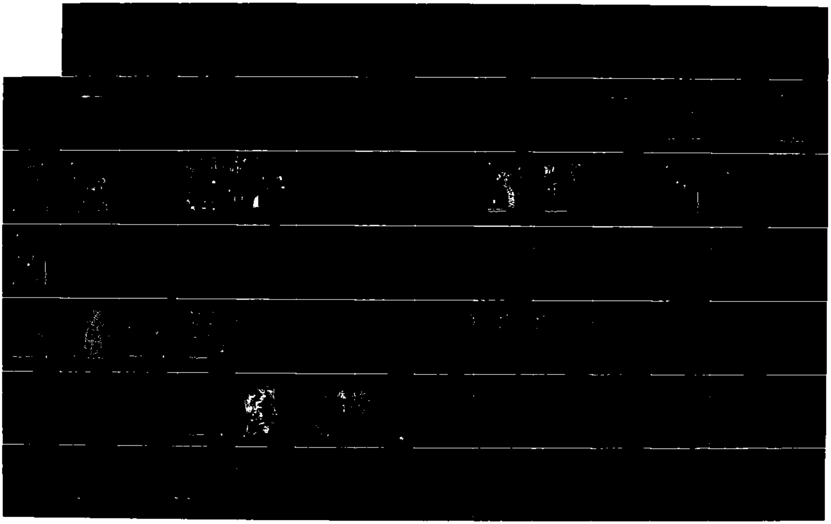
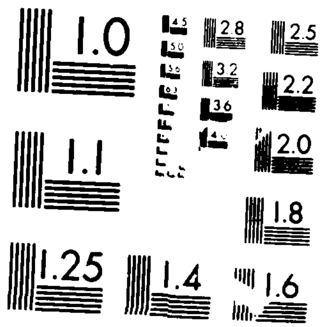


FIGURE 2-6 STRUCTURAL GEOLOGY MAP PEASE AFB

AD- 184 842 INSTALLATION RESTORATION PROGRAM 2 2/4
CONFIRMATION/ QUANTIFICATION STAG..(U) WESTON (ROY F)
INC WEST CHESTER PA R L KRAYBILL ET AL. AUG 87
UNCLASSIFIED F33615-84-D4400 F/G 24/4 NL





MICROCOPY RESOLUTION TEST CHART

Pease AFB lies just southeast of the axis of the Great Bay Syncline, which trends northeast-southwest and is approximately followed by the flow of the Exeter/Squamscott River, Great Bay, and Little Bay. A diorite pluton, also a linear feature trending northeast-southwest, extends from the core of the Exeter Anticline 2 to 4 miles northwest of Pease AFB (Novotny, 1969).

2.7 HYDROGEOLOGY

Groundwater at Pease AFB is found in both the unconsolidated material and in the fractured bedrock at depths ranging from the ground surface to 32.3 feet below land surface datum (LSD). Bradley (1962) found piezometric conditions in the area varying from flowing artesian conditions to 37.4 feet below LSD, and seasonal variations of over 6 feet in till, 1 foot in sands, and 5.5 feet in bedrock in selected wells. Since Pease Air Force Base is located on a peninsula bordered by Great and Little Bays and the Piscataqua River, groundwater flow is generally radial in nature, from the axis of the peninsula toward discharge points at the edges.

Unconsolidated water-bearing formations at Pease AFB fall into three major categories: glacial till, glacial kame deposits, and marine deposits. Glacial till at Pease AFB exists as unsorted, moderately to highly compacted glacial debris in a ground moraine, with an irregular rolling surface. Till thickness generally does not exceed 40 feet (Meyers and Bradley, 1960). Due to its low hydraulic conductivity, the glacial till exhibits a low water-bearing capacity, although there are many shallow dug wells in till in the seacoast region. These wells have historically provided sufficient quantities of water (1 to 2 gallons per minute) for rural homes and small farms; however, large fluctuations in water table elevations are common and some hand-dug wells go dry in summer months.

Glacial ice-contact deposits occur at Pease AFB as medium to coarse-grained sands and gravels in a relatively flat elongated kame plain deposit. Maximum reported thicknesses for these deposits in the area are 150 feet (Meyers and Bradley, 1960). Ice-contact deposits in the area exhibit high hydraulic conductivities and are capable of providing sufficient quantities of water for large public water supply wells. Bradley (1962) found potential well yields of up to 700 gallons per minute (gpm) in many places where saturated

thicknesses exceed 50 feet. The 24-inch diameter Haven well on Pease AFB is rated at 800 gpm with 13.7 feet of drawdown. Prior to the construction of Pease AFB, the City of Portsmouth derived much of its water supply from large diameter, gravel-packed wells and two batteries of 2.5-inch well point systems in the ice-contact deposits. A local brewery utilized a series of 8-foot diameter dug wells, located in the southwest corner of the base, to meet its water needs.

Marine deposits at Pease AFB are primarily fine-grained deposits of silt and clay and have been found locally to reach thicknesses of up to 75 feet. These deposits rarely produce sufficient yields for water supply wells. Due to the low hydraulic conductivities of these deposits, they frequently act as aquitards separating water-bearing deposits. Artesian conditions have been encountered in glacial tills and bedrock which underlie marine clays in and around Pease AFB. These conditions were noted during the Phase II investigations.

Fractured metamorphic bedrock underlying the Pease AFB area also serves as a source of potable drinking water. Stewart (1968) reviewed data from 94 bedrock wells in the towns of Greenland, Newington, and Portsmouth, New Hampshire, and found an average yield of 13.4 gpm from an average depth of 118.4 feet. The total depths of the wells ranged from 40 to 500 feet. Bradley (1962) cited a bedrock well in Newington which produced 75 gpm, but other wells in the area generally yield from 5 to 25 gpm. Groundwater in bedrock occurs primarily in fractures; the availability, flow direction, and flow velocity are controlled by fracture patterns (including fracture orientation, width, and frequency). In southeastern New Hampshire, the most common fractures are oriented vertically or near vertically; fracture width and frequency tend to decrease with depth (Phase I Report).

2.8 BACKGROUND WATER QUALITY

New Hampshire classifies its surface waterways according to potential uses based on water quality. The tidal areas of the Piscataqua River and the Bays and the streams feeding them are classified as Class B (suitable for bathing, recreation, fish habitat, and public water supply after adequate treatment). Discharge of untreated sewage or wastes to Class B waters is prohibited. Water quality in the tributary rivers feeding the Great Bay has reportedly

been degraded due to ongoing industrial and municipal discharges upstream from the area of Pease AFB; in general, stream water quality does not meet requirements for Class B (Phase I Report, 1984). These requirements are outlined in Appendix J. Water in the tidal reaches is brackish and is, therefore, not considered as potable water supply. However, estuaries are highly productive areas for development of aquatic communities, and food chains in these communities are potentially sensitive to man-made contaminants.

The most important groundwater aquifer in the area of Pease AFB occurs in the ice-contact or kame deposits underlying the flightline. Natural groundwater quality in this aquifer is good and is suitable for drinking water purposes. Bradley and Peterson (1962) reported the following ranges for inorganic water quality parameters sampled during 1951-54 in the Portsmouth supply wells located in the ice-contact deposits prior to installation of Pease AFB:

Silica	13 ppm
Total Iron	0.01 ppm
Calcium	26-39 ppm
Magnesium	10-12 ppm
Sodium	5.2-7.7 ppm
Potassium	1.5-2.2 ppm
Bicarbonate	72-110 ppm
Sulfate	52-54 ppm
Chloride	6.2-9.0 ppm
Nitrate	0.2-3.6 ppm
Dissolved Solids	156-191 ppm
Specific Conductance	204-321 umhos
pH	7.1-7.6

The ice contact/kame deposit aquifer is vulnerable to contamination from surface sources, but it also has a high capacity for contaminant mitigation through dilution due to the high volume of water in storage and the high volume of annual recharge through permeable surface soils.

Contamination of an undetermined extent in portions of the ice contact/kame plain deposits with trichloroethylene and associated other organic halocarbons, as cited in Section 1.3.3.5.2, was noted in the late 1970's; but by 1983, a decrease in contaminant levels had occurred without the aid of specific remedial activities.

SECTION 3

FIELD PROGRAM

3.1 PROGRAM DEVELOPMENT

Based on the conclusions of the Phase I Records Search, the Phase II Presurvey Report, and the overall HARM score ratings, sixteen sites at Pease AFB were recommended for Phase II Stage 1 Confirmation Study Investigations. Two sites listed in the Phase I report (Site 16: PCB Spill Site, and Site 18: Munitions Residue Burial Site) were not recommended for further study. Three additional sites (Sites 19, 20, 21: the Newfields Ditch, Grafton Ditch, and McIntyre Brook) were added to the list of sites requiring further study, bringing the total to nineteen sites. An additional suspected fire training area was identified from aerial photographs prior to the start-up of Phase II field activities. This new site was named Site 22, and brings to twenty the number of sites investigated during the Phase II Stage 1 study. Actions recommended in the Phase I Report were reviewed at the time of the Presurvey and modified as necessary by agreement between USAFOEHL, Pease AFB, and WESTON.

Sites that were similar in nature or in close proximity to one another were grouped together in zones. A total of ten areas were investigated. Table 1-3 presented the organization of the sites into individual sites and zones comprised of groups of sites. The following subsections review the development of the scope of work on a site-by-site basis. The analytical protocol for each site is summarized in Table 3-1. The contract scope of work is included in Appendix B.

3.1.1 Fire Department Training Area 2 (FDTA-2) - Site 8

The Phase I Report recommended the placement of five monitoring wells at FDTA-2: four hydraulically downgradient of the site and one upgradient to assess background water quality. The Phase I Report specified 4-inch diameter casing be used and that the wells be sampled twice. As an alternative to these recommendations, WESTON suggested in the Presurvey Report that prior to siting of the monitoring wells, a test pit investigation be instituted to help delineate the lateral extent of hydrocarbon contamination in the unsaturated zone. If saturated conditions were

TABLE 3-1

ANALYTICAL PROTOCOL FOR PHASE II, STAGE I SITES

Zone	Site	Sample Type and Number (1)	Analytes
--	8	6 soil	TOX, O&G
		13 groundwater	TOX, TOC, O&G
1	13	9 groundwater	TOX, TOC, O&G
		2 surface water	TOX, TOC, O&G
1	Sites 2,3,4,&5	11 groundwater	TOX, TOC, O&G, CN, pesticides, phenols, metals
		15 surface water	TOX, TOC, O&G, CN, pesticides, phenols, metals
2	7	3 soil	TOX, O&G
		2 groundwater	TOX, TOC, O&G
2	1	6 groundwater	TOX, TOC, O&G, CN, pesticides, phenols, metals
		9 surface water	TOX, TOC, O&G, CN, pesticides, phenols, metal
3	15	17 soil	TOX, O&G, phenols, metal, VOC
		16 groundwater	TOX, TOC, O&G, phenols, metal, VOC
		2 tank	TOX, TOC, O&G, VOC
4	Sites 19,20,21	7 sediment	TOX, O&G, metals
		13 surface water	TOX, TOC, O&G, metals
4	Production Wells	13 groundwater	TOX, TOC, O&G, metals, VOC
--	12	3 sediment	TOX, O&G
		4 surface water	TOX, TOC, O&G
		2 groundwater (abandoned production wells)	TOX, TOC, O&G
--	9	7 surface water	TOX, O&G
		5 groundwater	TOX, O&G
5	Sites 6 & 17	8 groundwater	TOX,TOC, O&G, phenols, metals
		13 surface water	TOX, TOC, O&G, phenols, metals
--	10	6 soil	O&G, lead
		7 groundwater	O&G, lead
6	11	4 soil	TOX, O&G
		2 groundwater	TOX, TOC, O&G
6	14	3 soil	O&G
		3 groundwater	O&G

(1) Includes QA/QC Samples

-- Considered individually

TOX - Total Organic Halogens
O&G - Oil and Grease
TOC - Total Organic Carbon
VOC - Volatile Organic Compounds

encountered, temporary monitoring points, consisting of 1-inch PVC pipe and VYON R screen, would be installed. The task order specified up to six soil samples would be taken from the test pits for chemical analysis. Following the completion of the test pit program, six 2-inch diameter PVC wells would be installed then and sampled on two occasions.

3.1.2 Zone 1: Bulk Fuel Storage Area (BFSA) - Site 13 and Landfills Nos. 2, 3, 4, & 5 (LF-2, LF-3, LF-4 & LF-5 - Sites 2, 3, 4 and 5

The Phase I Report determined that five monitoring wells would be sufficient to adequately monitor all five sites in Zone 1. The 4-inch diameter PVC wells would be sampled twice. WESTON determined that, due to the spatial arrangement of the sites within the zone, it would be necessary to install nine wells to effectively monitor groundwater in the area.

In addition, WESTON recommended that surface water be monitored at eight locations along Flagstone and Pauls Brook to assess the potential impacts of hazardous substances which may be emanating from the BFSA and/or the four landfills.

The task order specified that nine 2-inch PVC wells (four at the BFSA and five arranged around the landfills) and eight surface water monitoring locations would all be sampled twice. The sampling protocol would be structured to address discharges from all sites within the zone.

3.1.3 Zone 2: Landfill No. 1 (LF-1) - Site 1 and Fire Department Training Area No.1 (FDTA-1) - Site 7

The Phase I Report recommended that three 4-inch diameter monitoring wells be constructed around Zone 2 to detect any contaminant flow from either of the two sites.

WESTON recommended that, prior to the installation of any monitoring wells, a test pit investigation be conducted to better define the areal extent of FDTA-1. Field screening of soils for volatile organic contamination and laboratory analysis of three soil samples would be used to site four 2-inch diameter PVC wells.

WESTON also recommended that Upper and Lower Peverly Ponds be sampled at a total of four locations. The samples would

address potential surface water degradation by these two sites. The task order specified that two rounds of water samples would be collected from a total of eight surface and groundwater sampling points.

3.1.4 Zone 3: Industrial Shop/Parking Apron(IS/PA) - Site 15

The Phase I Report recommendations addressed the need for proper housekeeping practices, but did not suggest any field investigative alternatives for the site. WESTON's recommendations for this zone address potential contamination of ground and surface waters as a result of waste handling and disposal practices at a wide variety of base support operations. Test borings, drilled with a portable power auger, were recommended in the Phase II Presurvey Report to allow screening of soil material for the presence of detectable volatile organic constituents, including trichloroethylene. These data would be used to delineate potential source areas of contamination. Where water-table conditions were encountered, temporary monitoring points, similar to those described above, would be installed. Up to 17 soil samples would be obtained for laboratory analysis. Areas of particular concern were Buildings 113, 119, 222, 244, and the former liquid oxygen plant.

Up to six liquid samples from temporary monitoring points or abandoned underground storage tanks were also recommended. These samples would be screened in the laboratory for total organic halogens (TOX), total organic carbon (TOC), oil and grease (O & G) and Priority Pollutant Volatile Organic Compounds (VOC).

Seven permanent monitoring wells were proposed for this zone. All seven wells would be constructed of two-inch diameter PVC pipe and screen. The task order specified that the seven wells would be sampled twice.

3.1.5 Zone 4: Storm Drains and Supply Wells - Sites 19, 20 and 21

The Phase I Report recommended that the two production wells, MMS-1 and MMS-2, be sampled and analyzed for Priority Pollutant Volatile Organic Compounds (VOC). No recommendations were made pertaining to the hydrogeology or surface water quality of the site.

The New Hampshire Water Supply and Pollution Control Commission (NHWS&PCC) has expressed concern for water quality conditions in this zone, which includes Grafton Ditch, Newfields Ditch, and McIntyre Brook (Sites 19, 20, and 21, respectively). A combination surface water and groundwater sampling program was recommended. Sites 19, 20 and 21, would each be sampled at two locations on two occasions. Two locations were recommended to monitor water quality changes with distance from the outfalls. Additionally, it was proposed to sample each of the six base production wells on two occasions. These samples were suggested to address the State's concern regarding regular monitoring of supply wells. The task order specified that six surface water sampling points and six active supply wells would be sampled twice. In addition, six samples of stream sediment would be collected for chemical analysis to provide indications of the effects of prior waste discharge activities.

3.1.6 Munitions Storage Area Solvent Disposal Site (MSA) - Site 12

Reported past use and disposal of solvents at MSA and the proximity of the site to one of the base supply wells (Figure 1-9) prompted the Phase II Presurvey Report recommendation that a power auger investigation be conducted in the area where small amounts of solvents were dumped on the ground. Up to three soil samples from auger borings were to be obtained for chemical analysis. Small diameter temporary monitoring points, similar to those described above, would be installed if water table conditions were encountered.

Two sets of surface water samples from two unnamed tributaries topographically downgradient of the site were also recommended to assess what, if any, impact waste disposal practices at the MSA had on surface water quality.

3.1.7 Construction Rubble Dump No. 1 (CRD-1) - Site 9

The Phase II Presurvey Report recommended and the task order specified that an attempt be made to locate and sample two existing water supply wells. Further, the Task Order specified sampling and analysis of three points on Pickering Brook. No recommendations were made for the CRD-1 in the Phase I Report.

WESTON

3.1.8 Zone 5: Landfill 6 (LF-6) - Site 6, and Construction Rubble Dump 2 (CRD-2) - Site 17

Hazardous material possibly disposed of at LF-6 and CRD-2 has the potential to adversely impact groundwater and surface water in that area of Pease AFB. To address this concern, WESTON recommended that four exploratory borings be drilled around the perimeter of the zone and that a 2-inch diameter PVC well be installed in each boring. Additionally, six surface water sampling locations were selected to assess potential impacts of waste materials on streams and wetlands in the zone. The Task Order specified that a total of ten surface and groundwater sampling points be sampled twice.

3.1.9 Leaded Fuel Tank Sludge Disposal Site (LFTS) - Site 10

No recommendations were made for the LFTS in the Phase I Report. Drums of sludge generated during the cleaning of the AVGAS storage tanks were reportedly buried in an area west of the northern end of the runway. The precise location of the disposal site was not known; accordingly, WESTON recommended that geophysical studies be conducted with ground penetrating radar (GPR) and a flux gate magnetometer to identify the area of concern. The site location would be confirmed by a test pit investigation during which up to six soil samples would be obtained for chemical analysis.

Three 2-inch diameter PVC wells would subsequently be installed and sampled to determine if former site activities had impacted the surrounding groundwater. The Task Order specified that the three wells be sampled twice each.

3.1.10 Zone 6: FMS Equipment Cleaning Site (FMS) - Site 11, and Fuel Line Spill Site (FLS) - Site 14

No recommendations were made for field investigative work at Zone 6 in the Phase I Report. Intermittent disposal of waste solvents at the FMS site and a reported fuel spill at the FLS site prompted the recommendation by WESTON that a test pit and power auger investigation and soil sampling program be instituted to aid in identifying the actual disposal/spill sites. A portable organic vapor detector would be used to field screen soils and delineate the areas of concern.

Up to six soil samples were specified for laboratory analysis. Two 2-inch PVC monitoring wells were to be installed in the zone to monitor groundwater flow and quality. Each

well would be examined for floating hydrocarbons, and would be sampled twice.

3.2 FIELD INVESTIGATIONS

A field investigation incorporating the site-specific elements described above was conducted. The objectives of this field investigation were: (1) to confirm the presence or absence of environmental contamination within specified sites or zones of investigations; (2) if contamination exists, to determine the potential for contaminant migration in the various environmental media; (3) to identify additional investigations necessary to determine the magnitude, extent, direction and rate of contaminant migration; and (4) identify potential environmental consequences and health risks of migrating pollutants.

Information regarding potential or actual impacts of the 20 sites on area ground and surface waters was obtained from 35 monitoring wells, 31 test pits, 31 power auger borings, 29 surface water sampling locations, six sediment sampling locations, six production wells, two abandoned storage tanks, a geophysical survey, a topographic survey of locations, top of casing elevations and water levels at all monitoring wells, a review of all available aerial photographs, a literature search of local hydrogeologic conditions, and a compilation of a local well inventory. Two rounds of surface water and groundwater monitoring and a single round of soil and sediment monitoring were performed in accordance with the approved analytical protocols (Table 3-1).

3.2.1 Schedule of Activities

The field investigation at Pease AFB commenced on 25 October 1984 and was completed in late 1985. Table 3-2 is a schedule of field activities completed at Pease AFB.

3.2.2 Analytical Program

The sampling and analytical program at Pease AFB encompassed five sample matrices: soils, stream sediments, surface water, groundwater, and wastes. Single soil samples were collected from selected tests pits and power auger borings based upon visual characterization of the soil and *in situ* screening of samples with an HNu. Single sediment samples were collected at six locations. Surface water and

Table 3-2

Schedule of Field Activities
Pease AFB Phase II Stage 1 Study

Date	Activity
17-18 October 1984	Pre-performance meeting at Pease AFB.
25-26 October 1984 and 8-9 January 1985	Excavation of 31 test pits
22-25 October 1984	GPR/magnetometer study
7-9 November 1984	Collection of sediment samples and round 1 surface water and production well samples.
15 November 1984 through 22 February 1985	Drilling, construction, and development of 35 monitoring wells
19-20 November 1984 27-28 December 1984 9-25 April 1985	Drilling of power auger holes
1-2 March 1985	Collection of data for base well inventory.
11-13 March 1985	Collection of round 2 surface water and production well samples.
19-26 March 1985 and 2-3 April 1985	Collection of round 1, groundwater samples
29-30 April 1985 2-7 May 1985	Collection of round 2, groundwater samples.
11-24 May 1985	Survey of locations and elevations of monitoring wells and locations of test pits and power auger borings.
6 August through 14 September 1985 1 January 1986	Resampling of surface water, monitoring well, production well, soil, and sediment sampling locations.

groundwater samples were collected on two occasions and a single sample was collected from each of two underground waste TCE tanks. The sampling methods and sampling Quality Control are described in Appendix F.1.

An additional ten percent of the total number of samples was collected at sites specified in Table 2 of the Task Order 25 (see Appendix F.1) as quality control samples. These samples were either field duplicates or field blanks. The field blanks were prepared using distilled water and decontaminated sampling equipment.

Duplicate samples were collected at all locations and were forwarded to the USAFOEHL laboratory at Brooks AFB, with completed copies of Air Form 2752, for analysis.

Prior to the collection of all water samples, the sample bottles were rinsed with water from the sample location. Following sample collection, the sample equipment was triple rinsed with distilled water and methanol.

3.2.3 Power Auger, Test Pit, and Monitoring Well Installation Program

Power auger borings, test pits, and groundwater monitoring wells were installed in specified locations at various sites to assess the lithologic and hydrogeologic characteristics and to better define the extent of potentially contaminated soil, groundwater and surface water. The exact locations of each were determined in the field by the senior on-site contract representative in consultation with the base point of contact and the driller. All excavated materials were field screened with an HNu photoionzation detector and visually examined to determine whether the waste should be containerized and analyzed for hazardous constituents. Test pits were excavated in areas with easy access, and where their excavation would not destroy pavement or lawns; power auger borings were drilled in less accessible areas, in areas where it was necessary to minimize disturbance to paved areas or lawns, and to provide data to augment the test pit investigation data. Subsections 3.2.2.1 through 3.2.2.3 provide general descriptions of field methods. Subsections 3.2.2.4 through 3.2.2.11 describe the specific field investigations carried out at the individual zones or sites.

3.2.3.1 Power Auger Program

Power auger borings were performed to expand the lithologic and chemical information of specific sites. This information was used to identify optimum well locations and to

indicate the lateral and vertical extent of soil contamination by visual examination of soil material and by laboratory analyses of selected samples. Auger borings were completed with a hand-held Little Beaver Power Auger using 4-inch outside diameter solid stem augers. Borings were typically advanced five to ten feet or to a point at which saturated groundwater conditions were encountered.

Soil samples from specified depths were taken with a hand auger, placed into 1-liter amber glass jars, and shipped to the WESTON and USAFOEHL laboratories for chemical analysis. Detailed sampling procedures are described in Appendix E. Agitated soil samples and down-hole ambient conditions were screened with an HNu model PI101 photoionization meter for the presence of volatile organic vapors as power augering proceeded.

Piezometers were installed in the power auger borings when saturated groundwater conditions were encountered to allow examination of the water table surface for the presence of hydrocarbons and measure the thickness of the hydrocarbon layer when present. Piezometers were constructed of 1-inch nominal diameter Schedule 40 PVC pipe. VYON R, a high density porous polyethylene tubing, was used for the screened interval. The screened interval extended approximately two feet into the saturated zone. The annular space around the VYON tubing was backfilled with No. 2 "Sakrete" sand. A bentonite grout seal approximately one foot thick was placed above the sand pack. The remainder of the boring was backfilled with native soil material. Figure 3-1 is a diagram of a typical piezometer installation. Power auger logs are included in Appendix D.

An alphanumerical numbering system was devised for the power auger and test pit programs. The alphanumeric designation indicates the site at which the boring or test pit appears, whether it is a power auger boring or backhoe test pit, and its assigned number within the site. For example, number 12-B-1 was the first (1) boring (B) at Site 12; number 7-TP-2 was the second (2) test pit (TP) at site 7. A suffix of "P" indicates that water table conditions were encountered and a piezometer was installed. Table 3-3 lists the permanent identification number, the number as it appears on the chain-of-custody form and chemical analyses reports, and other pertinent data about the boring or test pit.

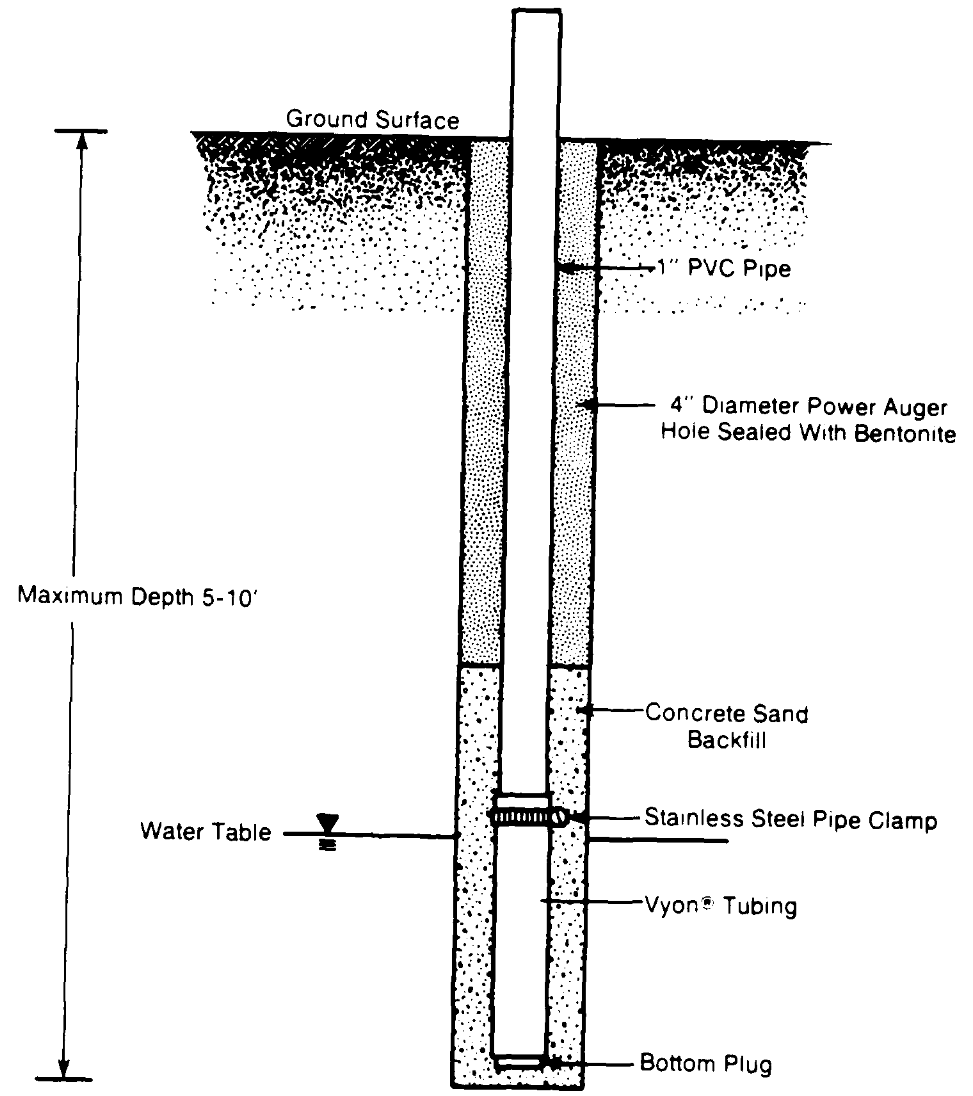


FIGURE 3-1 TYPICAL PIEZOMETER INSTALLATION

Table 3-3

SUMMARY OF BORING AND TEST PIT DATA

Test Pit Boring No.	Site	Depth (feet)	Depth to Water Table (feet)	Dominant Lithology
7-TP-1	FDTA 1	6.5	*	Fine to coarse gravel
7-TP-2	FDTA 1	8.0	*	Fine to coarse gravel
7-TP-3	FDTA 1	6.0	*	Fine to coarse gravel
8-TP-1	FDTA 2	8.0	*	Medium sand and gravel
8-TP-2	FDTA 2	7.0	*	Fine to coarse gravel
8-TP-3	FDTA 2	10.0	*	Fine to coarse sand and gravel
8-TP-4	FDTA 2	9.0	*	Fine to medium sand
8-TP-5	FDTA 2	7.0	*	Fine to coarse sand
8-TP-6	FDTA 2	8.0	*	Fine to coarse sand
8-TP-7	FDTA 2	8.0	*	Fine to coarse sand and gravel
8-TP-8	FDTA 2	6.5	*	Medium to coarse sand and gravel
8-TP-9	FDTA 2	10.0	*	Medium to coarse sand and gravel
8-TP-10	FDTA 2	9.0	*	Medium to coarse sand and gravel
10-TP-1	LFTS	7.5	*	Fine to coarse gravel and sand
10-TP-2	LFTS	7.0	*	Fine to coarse gravel and sand
10-TP-3	LFTS	9.0	*	Fine to coarse sand
10-TP-4	LFTS	5.0	*	Fine to coarse sand
10-TP-5	LFTS	7.0	*	Fine to coarse sand and gravel
10-TP-6	LFTS	3.0	*	Fine to coarse gravel
11-TP-1	FMS	8.0	*	Fine to medium sand
11-TP-2	FMS	9.0	*	Fine to medium sand
11-TP-3	FMS	9.0	*	Fine to coarse sand
11-TP-4	FMS	9.0	*	Fine to coarse sand
11-TP-5	FMS	8.0	*	Medium to coarse sand, little gravel
11-TP-6	FMS	8.0	*	Fine to coarse sand, clayey till
11-TP-7	FMS	9.0	*	Fine to medium sand

* Water table not encountered

Table 3-3
(cont.)

Test Pit Boring No.	Site	Depth (feet)	Depth to Water Table (feet)	Dominant Lithology
12-B-1	MSA	3.0	*	Fine to coarse sand and gravel
12-B-2	MSA	3.0	*	Fine to coarse sand and gravel
12-B-3	MSA	9.0	9.0	Fine to coarse sand and gravel
14-B-1	FLS	6.5	*	Coarse gravel, fine sand
14-B-2	FLS	3.0	*	Fine to medium sand
14-B-3	FLS	10.0	*	Medium to coarse gravel, fine to medium sand
14-B-4	FLS	10.5	*	Fine to medium sand
15-B-1-P	IS/PA	10.0	3.5	Fine to coarse sand, silty clay
15-B-2-P	IS/PA	10.0	6.0	Fine to coarse sand,silty clay
15-B-3-P	IS/PA	10.0	6.0	Fine to coarse sand, silty clay
15-B-4-P	IS/PA	6.0	4.0	
15-B-5-P	IS/PA	9.0	6.0	Medium to coarse sand, clay
15-B-6	IS/PA	8.0	*	Fill, fine to medium sand, clay
15-B-7	IS/PA	6.5	*	Medium to coarse sand
15-B-8	IS/PA	11.0	*	Fine sand
15-B-9	IS/PA	11.0	*	Fine sand
15-B-10-P	IS/PA	6.0	*	Fine sand, some silt
15-B-11-P	IS/PA	4.5	3.0	Fine sand, some silt
15-B-12	IS/PA	6.5	*	Medium sand,some silt
15-B-13	IS/PA	8.0	*	Medium to coarse sand,clay
15-B-14	IS/PA	10.0	*	Fine sand
15-B-15	IS/PA	11.0	*	Fine to medium sand
15-B-16-P	IS/PA	8.5	8.0	Fine to medium sand, some silt
15-B-17-P	IS/PA	11.5	10.0	Fine to medium sand, some silt
15-B-18	IS/PA	6.5	*	Medium to coarse sand and gravel
15-B-19	IS/PA	5.5	*	Medium to coarse sand, some silt
15-B-20	IS/PA	4.0	*	Gravel fill

*Water table not encountered

Table 3-3
(cont.)

Test Pit Boring No.	Site	Depth (feet)	Depth to Water Table (feet)	Dominant Lithology
15-B-21	IS/PA	5.5	*	Coarse gravel
15-B-22	IS/PA	8.0	8.0	Fill, medium to coarse fill and silty sand
15-B-23	IS/PA	5.0	*	Coarse gravel
15-B-24	IS/PA	9.5	*	Fine to medium sand, clay
22-TP-1	Site 22	7.0	*	Fine to coarse gravel
22-TP-2	Site 22	5.0	*	Fine to coarse gravel
22-TP-3	Site 22	7.0	*	Fine to coarse gravel
22-TP-4	Site 22	4.0	*	Fine to coarse sand and gravel
22-TP-5	Site 22	4.0	*	Fine to coarse sand and gravel

* Water table not encountered

3.2.3.2 Test Pit Installations

Test pits were excavated at five sites to obtain data on shallow soil lithology, to collect soil samples for laboratory analysis, and to determine the lateral extent of potential soil contamination. Test pit excavations were performed under WESTON's direction by Robinson Construction, Inc. of North Hampton, New Hampshire on 25 and 26 October 1984 and 8 and 9 January 1985. A Case 680 backhoe was used to excavate a trench approximately three feet wide, by eight feet long and six to ten feet deep. Soil samples were taken from representative portions of the excavated material and retained in wide-mouthed canning jars for archival purposes at WESTON's Concord, New Hampshire office. Additionally, selected samples were taken for chemical analysis from 15 test pits, placed in 1-liter amber glass jars, and forwarded to the WESTON and USAFOEHL laboratories. Further details of the sampling methods are contained in Appendix E. An HNu model PI 101 photoionization meter was used during test pit operations to field screen ambient air quality and soil for volatile organic vapors. A WESTON geologist supervised all test pit work and kept detailed records of the excavations. Test pit logs for all excavations are included in Appendix D. Table 3-3 summarizes the test pit and soil sampling work at each area. Following completion of sampling and logging procedures, all test pits were filled in and regraded.

3.2.3.3 Monitoring Well Drilling Procedures and Well Construction Details

Thirty-five monitoring wells were drilled at Pease AFB by Con-Tec, Inc., of Hooksett, New Hampshire. Drilling operations commenced in November 1984 and continued through March 1985. Two drill rigs were used: a truck-mounted Acker rig and a bombadier all-terrain vehicle-mounted rig.

Test borings were advanced, where possible, by 4-inch inside diameter, hollow-stem augers without the use of drilling fluids. Case and wash techniques, using 4-inch inside diameter hardened steel casing and tri-cone roller bits, were used in areas of high water table or difficult drilling. In areas where boulders were encountered, it was necessary to drill through the boulder with a tri-cone drill bit, then advance 3-inch inside diameter casing inside the 4-inch casing in order to continue drilling.

Bedrock refusal was confirmed in most holes by either advancing the boring with a tri-cone roller bit or by using

a 5-foot long, NX core barrel with a diamond impregnated bit to core the rock.

Drinking water quality water was used as drilling fluid during all case and wash and coring operations. The water was obtained from a fire hydrant located adjacent to Building 153. During drilling operations, the wash water was recycled.

Soil samples were obtained at 5-foot intervals using a standard 2-inch diameter, 2-foot long split-spoon sampler and Standard Penetration Test (SPT) techniques according to ASTM Standard Method No. D-1586. Soil samples were placed in wide-mouth screw-topped, glass jars and retained in archives at the WESTON office in Concord, New Hampshire.

An HNu Model PI-101 photoionization meter was used to screen split-spoon soil samples and air quality at the well head for the presence of detectable volatile organic vapors.

WESTON geologists were on-site during all drilling operations to supervise the well installation and to log the lithology of the borings. A written well log was kept for each boring; it included the following information:

- Sample number and type
- Blow counts
- Soil classification
- Boring number
- Dates
- Depth to water table
- Depth to bedrock
- Sample recovery
- HNu readings

This information and a sketch of the well construction were later transferred onto standard WESTON boring log sheets. The finished log sheets are included in this report in Appendix C. Table 3-4 lists construction details for each completed monitoring well.

After completion of each boring, the monitoring well was constructed using nominal two-inch inside diameter, Schedule 40 polyvinylchloride (PVC) pipe with flush-fitting threaded joints and Schedule 40 PVC No. 10 slot (0.010 inch) machine-slotted well screen with a threaded bottom cap. In general, wells were screened across the saturated thickness of the unconsolidated aquifer above bedrock. The annular space was

TABLE 3-4

SUMMARY OF MONITORING WELL CONSTRUCTION DETAILS

Well No.	Approx. Land Surface Elev.(1) (ft.)	Top of Casing(1) (ft.)	Below Ground Surface: Screened Interval (ft.)	Below Ground Surface: Ottawa Sandpack (ft.)	Below Ground Surface: Bentonite Clay Seal (ft.)	Below Ground Surface: Concrete Cap (ft.)	Geology of Screened Zone
RFW- 1	81.52	83.92	15-25	12-25	8.5-12	0-8.5	f-c sand, and clay, bedrock
RFW- 2	88.03	89.93	10-40	8-40	6-8	0-6	f-c sand, clay, till &bedrock
RFW- 3	99.63	102.12	15-30	14-30	12.5-14	0-12.5	bedrock
RFW- 4	108.41	110.59	8-25	6-25	4-6	0-4	f-c sand and bedrock
RFW- 5	97.90	99.70	18-28	13-28	10-13	0-10	f-c gravel, some sand, bedrock
RFW- 6	83.70	85.55	5-20	4-20	3-4	0-3	f sand & silt, bedrock
RFW- 7	61.98	64.41	3.5-18.5	3.5-18.5	2.5-3.5	0-2.5	f-m sand&silt, weathered bdrck
RFW- 8	71.44	73.37	12-22	10-22	8-10	0-8	bedrock
RFW- 9	49.03	47.52	11-21	9-21	3-9	0-3	till and bedrock
RFW-10	113.14	115.20	22-35	22-40	18-22	0-18	till
RFW-11	114.86	117.28	23-38	22-39	20-22	0-20	f-m sand, till gravel&bedrock
RFW-12	116.98	119.30	13-28	12-28	10-12	0-10	till and bedrock
RFW-13	111.66	114.12	22.5-40.5	20.5-40.5	18-20.5	0-18	bedrock
RFW-14	110.72	112.26	18-38	12-38	2-12	0-2	bedrock
RFW-15	108.09	110.12	9.5-29.5	5-31	2-5	0-2	till and bedrock
RFW-16	108.43	111.10	13-31.5	11-31.5	9-11	0-11	f-c sand, till & bedrock
RFW-17	97.57	99.70	8-25	6-25	4-6	0-4	m-c sand and bedrock
RFW-18 (2)	88.46	88.31	14.5-56.5	12-56.5	10-12	0-10	m-c sand, till
RFW-19 (2)	70.29	70.21	12-52	7-60	3-7	0-3	f-c sand and gravel
RFW-20 (2)	86.72	86.61	5-54.5	5-54.5	3-5	0-3	f-m sand, till, & bedrock
RFW-21 (2)	72.63	72.49	7-37	5-37	3-5	0-3	f-m sand, till & bedrock
RFW-22	59.07	61.26	7-24	5-24	3-5	0-3	m-c sand
RFW-23	55.97	58.14	5.5-22.8	4.7-23	2.7-4.7	0-2.7	f-m sand and bedrock
RFW-24	66.73	68.00	15-55.5	14-57	12-14	0-12	clay, fine sand, till & bedrock
RFW-25	100.89	102.86	28-45	26-45	24-26	0-24	clay, till, bedrock
RFW-26	109.02	111.45	44-62	43-62	39-43	0-39	vf sand, silt, till, bedrock
RFW-27	106.39	108.35	28-45	26-45	24-26	0-24	clay, till, and bedrock
RFW-28	95.22	97.29	19-53.5	17-53.5	15-17	0-15	m-c sand, clay, till&bedrock
RFW-29	41.64	43.93	18-24.5	16-24.5	13-16	0-13	till and bedrock
RFW-30	89.52	91.92	15-25	15-25	13-15	0-13	clay and bedrock

(1) from National Geodetic Vertical Datum (NGVD)

(2) Wells finished at ground level

TABLE 3-4 (cont)

SUMMARY OF MONITORING WELL CONSTRUCTION DETAILS

Well No.	Approx. Land Surface Elev.(1) (ft.)	Top of Casing(1) (ft.)	Below Ground Surface				Geology of Screened Zone
			Screened Interval (ft.)	Ottawa Sandpack (ft.)	Bentonite Clay Seal (ft.)	Concrete Cap (ft.)	
RFW-31	56.06	58.12	15.5-25.5	14-25.5	11-14	0-11	till and bedrock
RFW-32	23.93	26.09	7.5-17.5	5-17.5	3-5	0-3	clay&silt,till, & bedrock
RFW-33	34.88	37.17	18-40	15-40	12-15	0-12	till,some clay & bedrock
RFW-34	33.48	35.87	9.5-24.5	7-24.5	5-7	0-5	till and bedrock
RFW-35	38.10	40.27	14-49	13-49	11-13	0-11	till and bedrock

(1) from National Geodetic Vertical Datum (NGVD)

then backfilled with Ottawa sand to a point approximately five feet above the top of the well screen, where possible. A seal consisting of either bentonite pellets or a bentonite slurry was then tremied into place above the sand pack, followed by a concrete plug of Type I Portland cement. A protective casing of six-inch black steel, with a locking cap was placed over the PVC and set in the concrete plug. All locks used were keyed alike. A typical well construction diagram is presented in Figure 3-2. Monitoring well construction details for all the monitoring wells are summarized in Table 3-4. Finished depths of the wells varied from 28 to 40.5 feet below ground surface, and bedrock was confirmed by either NX core barrel or roller bit in all wells except RFW-10 and RFW-18. At these locations, nested boulders and coarse gravelly till prevented the advancement of the borings beyond 41 and 82 feet respectively. All wells were screened through the entire saturated thickness of the borehole.

The wells were developed by one of three methods: flushing clear water down the well until the overflow flowed clear and subsequently purging the well of development water, pumping the native groundwater from the well until it flowed clear, or purging the groundwater by means of a surge block until the effluent flowed clear. The methodology used was selected on the basis of the aquifer characteristics. The flushing method was used in low permeability material or where the water table was encountered below suction limits. The surge block method was used on four wells but was abandoned due to inherent mechanical problems. The remainder of the wells were developed by the pumping method. All non-native water introduced during development was drinking water quality water taken from the base hydrant described above.

3.2.3.4 Subsurface Investigations at Fire Department Training Area No. 2 - Site 8

A test pit investigation was conducted at an area of fuel-saturated soil northeast of the FDTA-2. A total of ten pits were dug around the site perimeter to estimate its lateral extent, and in areas of suspected highest contaminant concentration, to estimate depths of contamination. Test pit data were also used to refine monitoring well locations to assure optimum coverage of the site. An HNu Model PI-101 photoionization detector was used to field screen soil samples and ambient air quality during the investigation. Six soil samples were taken for chemical analysis. Figure 3-3 depicts the approximate locations of the test pits.

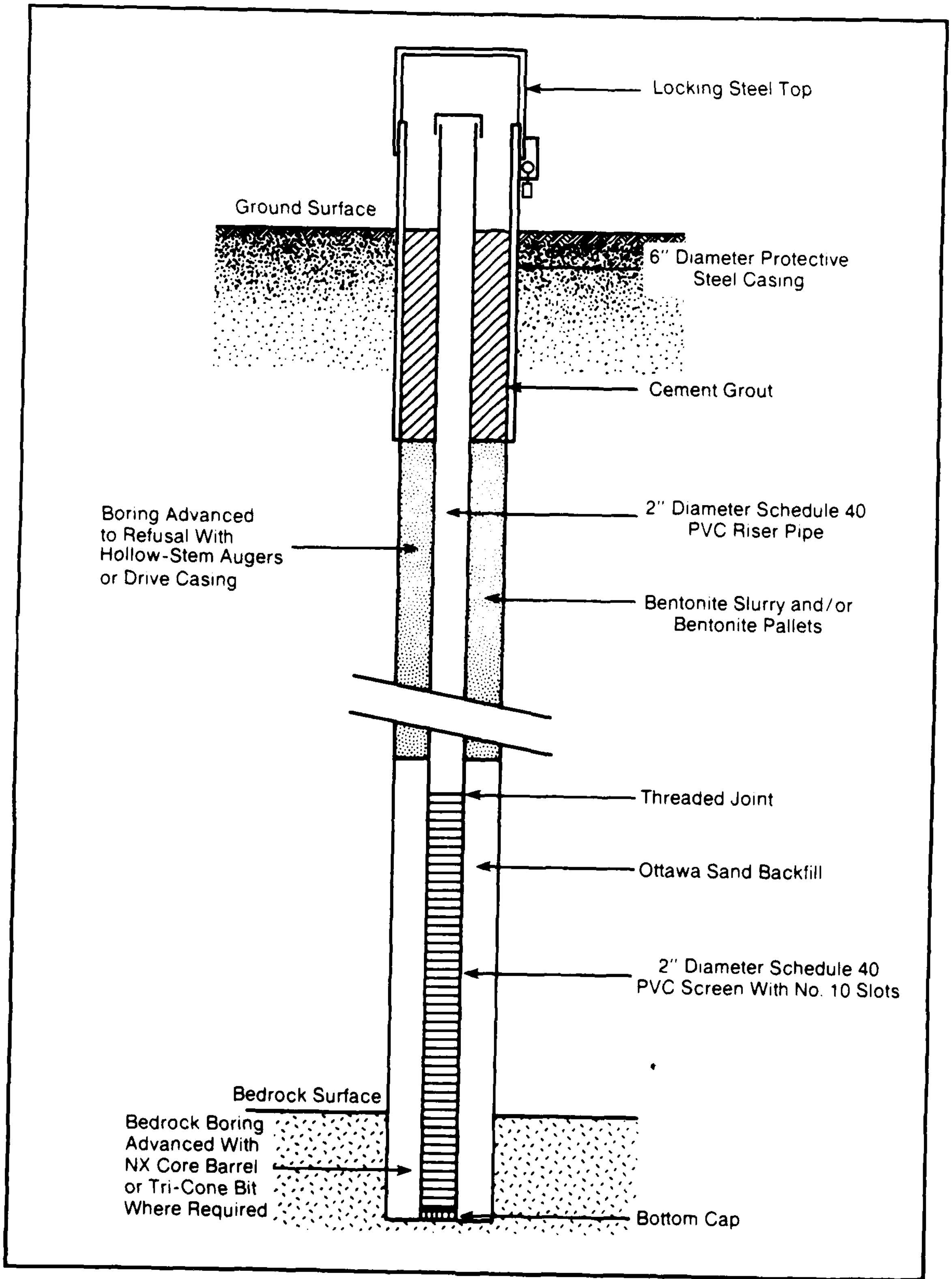


FIGURE 3-2 TYPICAL MONITORING WELL INSTALLATION

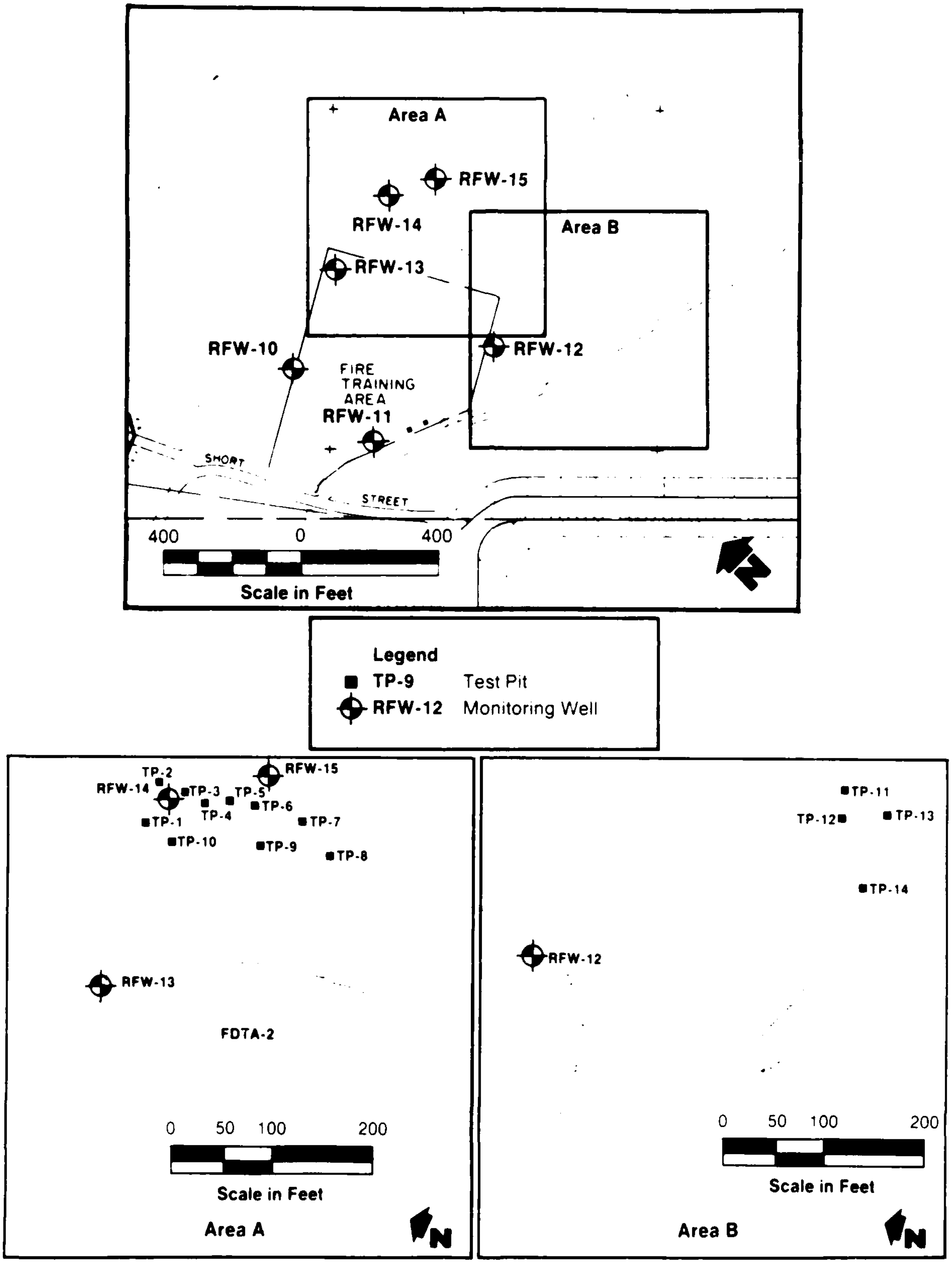


FIGURE 3-3 TEST PIT LOCATIONS FTDA-2 - PEASE AFB

Following completion of the test pit investigation, six groundwater monitoring wells were installed at FDTA-2. The wells, numbered RFW-10 through RFW-15, are shown in Figure 3-4. Locations were spatially arranged to provide monitoring data pertinent to both upgradient, (background) and downgradient water quality conditions.

3.2.3.5 Subsurface Investigations at Zone 1, Bulk Fuel Storage Area - Site 13, and Landfills 2, 3, 4, and 5 - Sites 2, 3, 4 and 5

Nine monitoring wells were installed in Zone 1, the northeast corner of Pease AFB, to assess impacts to the groundwater from the five sites within the zone (Figure 3-5). Wells RFW-1 through RFW-4 are situated on the four corners of the BFSA. The sites were selected as the optimum locations to intercept contaminated groundwater emanating from the area, and to evaluate ambient groundwater quality. Exploratory drilling depths ranged from 25 to 40 feet below ground surface. The wells were screened through the entire saturated thickness of the borehole to facilitate sampling for floating hydrocarbons. Bedrock was confirmed at each location by advancing with a roller bit at least five feet into rock.

Wells RFW-5 through RFW-9 were sited around landfills LF-2 through LF-5 to provide hydrogeologic and water quality data both upgradient and downgradient of the sites. The depths of the wells ranged from 18.5 to 28 feet below ground surface, and all wells were screened across the entire wetted thickness encountered in the borehole. The depth to bedrock was confirmed in each well by advancing a roller bit from 2 to 12.5 feet below LSD.

3.2.3.6 Subsurface Investigations at Zone 2: Fire Department Training Area 1 - Site 7, and Landfill 1- Site 1

A test pit investigation was performed at FDTA-1 in Zone 2 to gather in situ data concerning the lateral and vertical extent of soil contamination resulting from past disposal practices at the site. Locations of the test pits are shown in Figure 3-6. An HNu Model PI-101 photoionization detector was used to field screen soil samples and air quality during the investigation. Two soil samples were taken for chemical analysis.

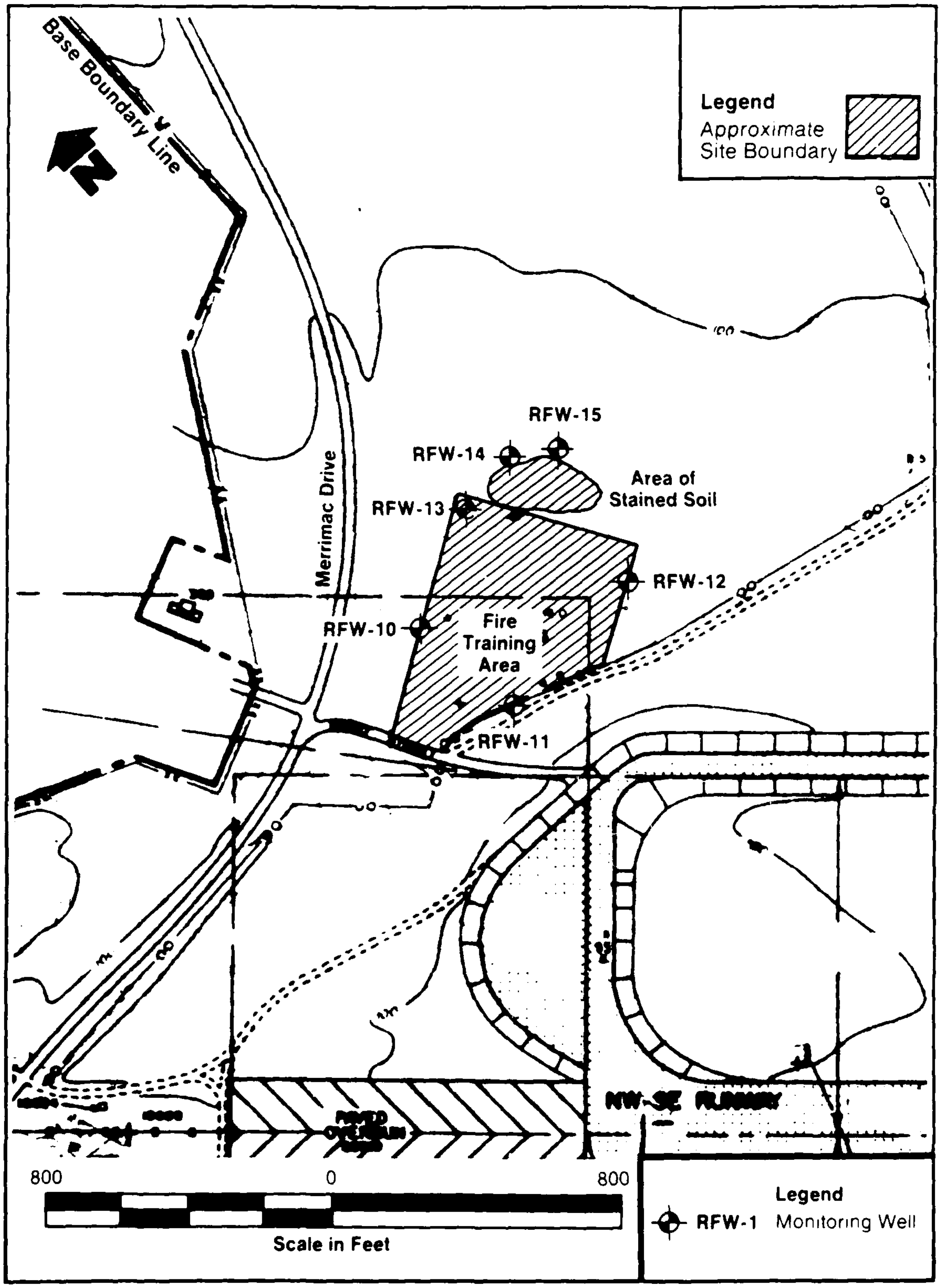


FIGURE 3-4 MONITORING WELL LOCATIONS FOR FDTA 2

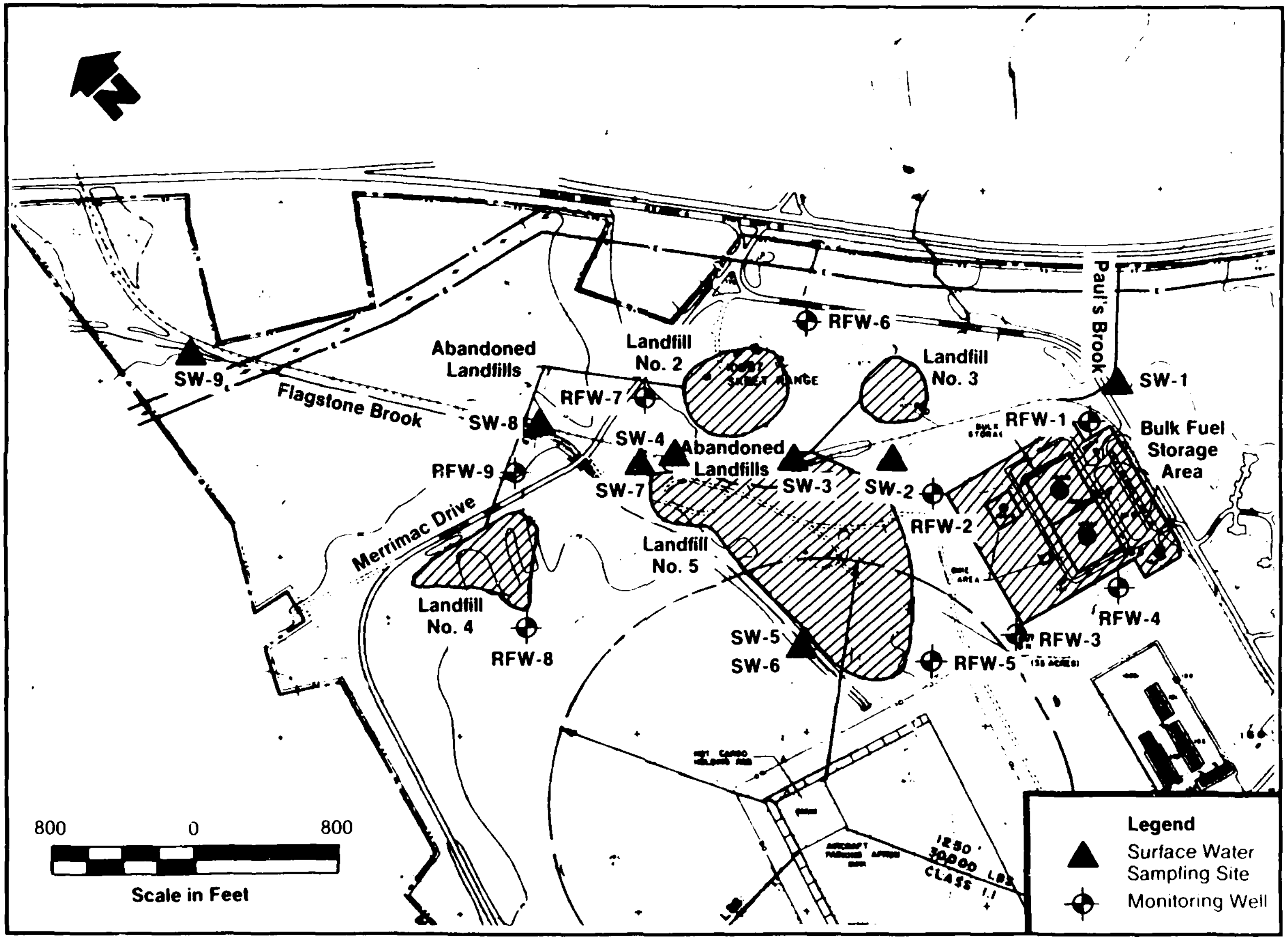


FIGURE 3-5 MONITORING WELL AND SURFACE WATER SAMPLING LOCATIONS FOR THE BFSA AND LF-2, LF-3, LF-4, AND LF-5

ZONE 1

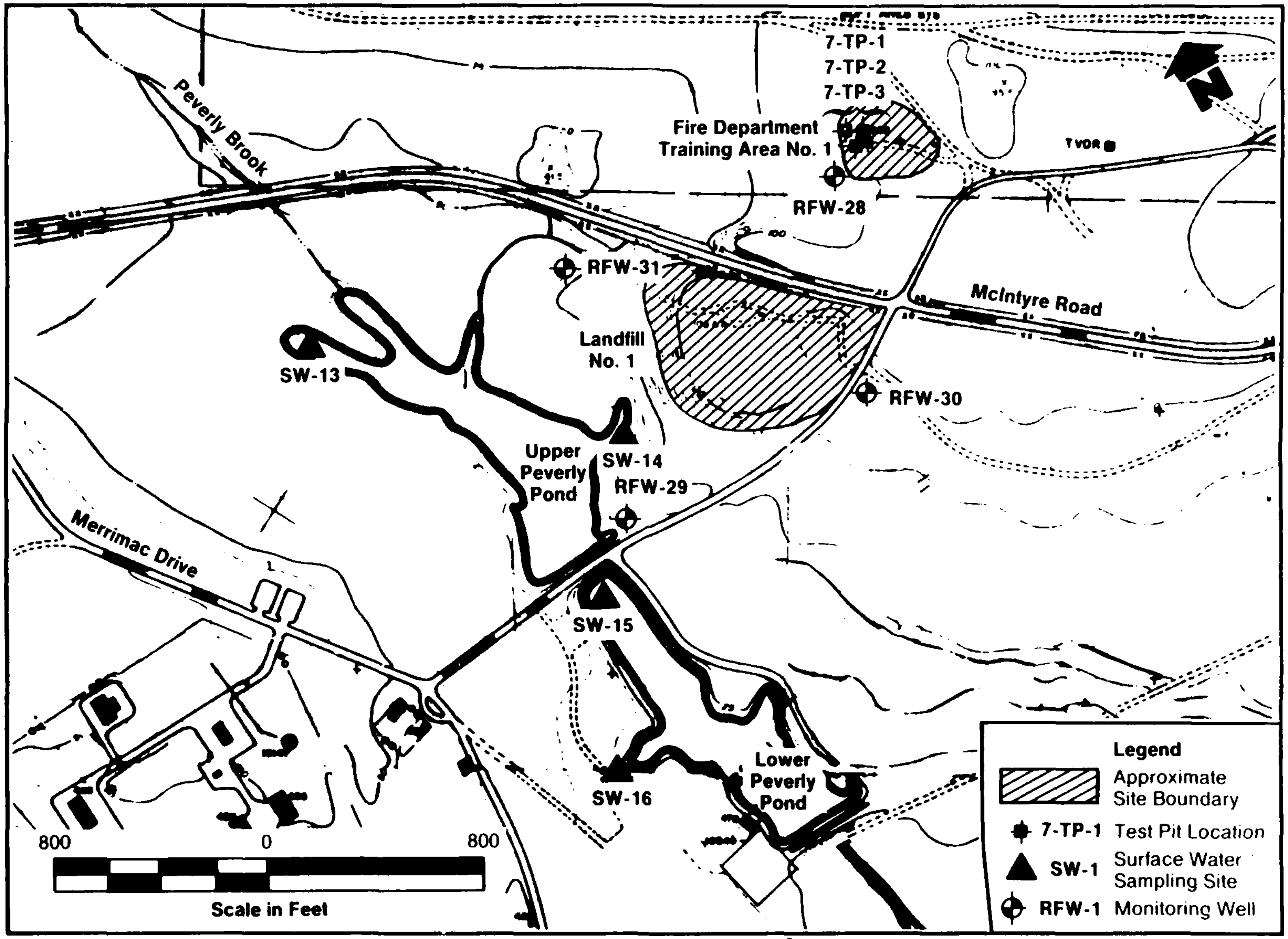


FIGURE 3-6 MONITORING WELL, SURFACE WATER SAMPLING AND TEST PIT LOCATIONS AT FDTA1 and LF-1 ZONE 2

Four monitoring wells were subsequently installed around the site as shown in Figure 3-6. Well RFW-28 was installed northwest of the FDTA-1 and screened through the entire zone of saturation to allow sampling for floating hydrocarbons. RFW-28 was drilled to 53.5 feet below LSD. Wells RFW-29, RFW-30, and RFW-31 were installed around the perimeter of LF 1 to detect the movement of any contamination migrating off-site, particularly toward the Peverly Ponds. The depths of the latter three wells were 24.5, 25, and 25.5 feet respectively. Each was screened beneath a semi-confining layer of marine clay to assess groundwater quality in that portion of the unconsolidated aquifer.

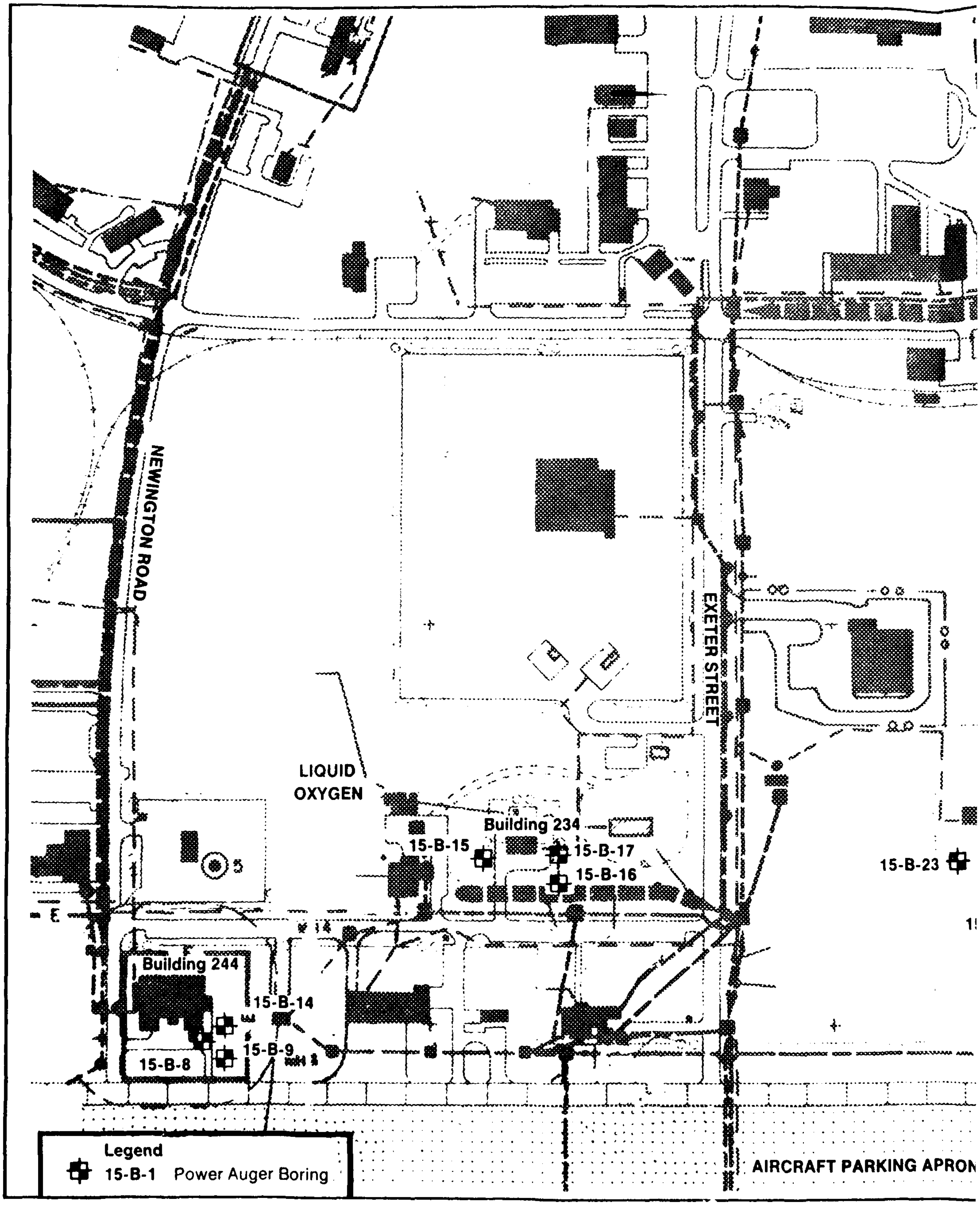
3.2.3.7 Subsurface Investigations at Zone 3: Industrial Shop/Parking Apron Area - Site 15

A total of 24 power auger borings were installed at the locations shown in Figure 3-7. The depths of the borings ranged from 4.0 to 11.5 feet below LSD. An HNu Model PI-101 photoionization meter was used to field screen soil samples and air quality for the presence of detectable levels of volatile organic compounds. At nine locations where saturated groundwater conditions were encountered, temporary piezometers were installed as described in Subsection 3.2.2.1. Seventeen soil samples, including one QA/QC duplicate, were collected for chemical analysis from eight subsites within the IS/PA.

Boring 15-B-1 was installed approximately 20 feet south of a waste solvent storage area at Building 119. A second boring, 15-B-2, was installed approximately 50 feet west of 15-B-1. Soils samples were collected from both borings for laboratory analysis. Water table conditions were encountered in both borings, and piezometers were installed in each.

Six power auger borings were installed at Building 113, the site of a former vapor degreasing operation and an associated underground waste TCE storage tank. The borings, numbered 15-B-3, 15-B-4, 15-B-19, 15-B-20, 15-B-21, and 15-B-22 were sited to the north, east and west of the tank to determine whether contaminated soil conditions exist at the subsite. Piezometers were constructed in Boring 15-B-3 and 15-B-4, and soil samples were collected from 15-B-3, 15-B-4, 15-B-19, and 15-B-22 for laboratory analysis.

Borings 15-B-5, 15-B-6, 15-B-7, 15-B-12 and 15-B-13 were installed south of a waste solvent staging area of Building


NEWINGTON ROAD
EXETER STREET
LIQUID
OXYGEN
Building 234
15-B-15
15-B-17
15-B-16
15-B-23
Building 244
15-B-14
15-B-9
15-B-8
AIRCRAFT PARKING APRON
Legend
15-B-1 Power Auger Boring

WESTON

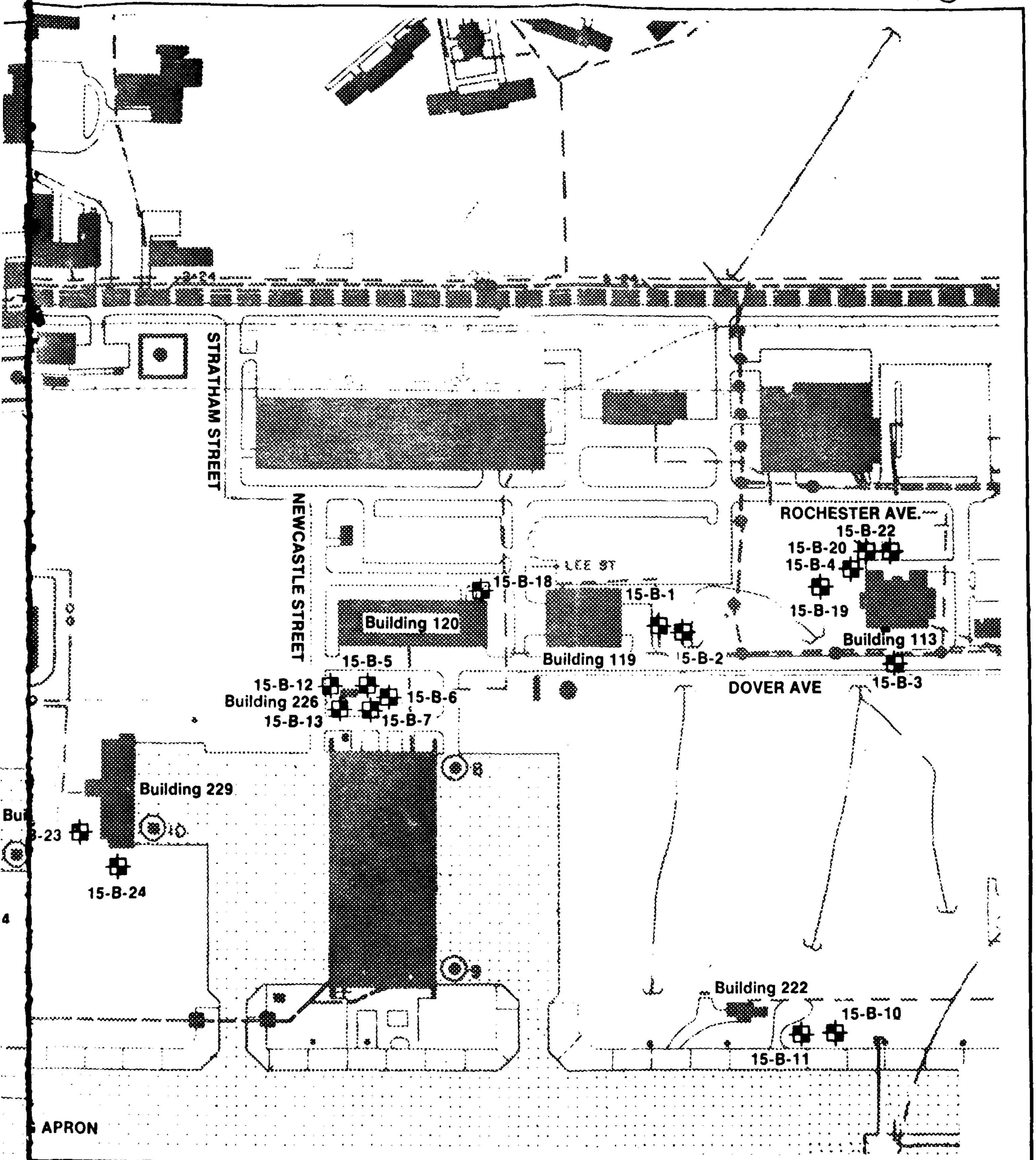


FIGURE 3-7 POWER AUGER BORING LOCATIONS
IS/PA ZONE B

1

2

226. A single piezometer was installed in Boring 15-B-5, and samples were taken from Borings 15-B-5, 15-B-6 and 15-B-7.

Power auger Borings 15-B-8, 15-B-9 and 15-B-14 were installed at Building 244, the site of a second abandoned underground waste TCE tank. The borings were drilled next to the tank (15-B-9) and in a drainage swale approximately 50 feet south of the tank. Soil samples were collected from 15-B-8 and 15-B-9 for laboratory analysis.

Borings 15-B-10 and 15-B-11 were drilled in a drainage swale, south of Building 222, in the vicinity of a reported fuel spill. Saturated conditions were encountered at both locations and, consequently, piezometers were installed in both borings. Soil samples were obtained from both borings for laboratory analysis.

Borings 15-B-15, 15-B-16 and 15-B-17 were installed at Building 234. It was reported that past operations at the building had resulted in the generation of waste solvents. Boring 15-B-15 was installed approximately 50 feet northwest of the building; 15-B-16 was installed approximately 75 feet southwest of the building; and 15-B-17 was installed next to a chain link fence approximately 50 feet south of the building. Soil samples were collected from 15-B-15 and 15-B-16, and piezometers were constructed in Borings 15-B-16 and 15-B-17.

A small area of dark stained soil was found at Building 120 next to the Paint Shop door. A power auger boring (15-B-18) was installed, and a soil sample was collected to determine if the stained soil was the result of waste material having been disposed of there.

Two borings (15-B-23 and 15-B-24) were installed approximately 100 feet west and 50 feet north, respectively, of Building 229. A soil sample was collected from 15-B-23 and a piezometer was constructed in the saturated soils encountered at the subsite in 15-B-23.

Seven monitoring wells, numbered RFW-18 through RFW-24, were installed around the perimeter of the site to assess groundwater quality and to determine the direction of groundwater flow from the area. The depths of the installed wells ranged from 22.8 to 56.5 feet below LSD. All wells were screened through the entire saturated thickness of the borehole. Bedrock was confirmed by roller bit at RFW-21,

RFW-22, and RFW-23, and by NX core barrel at RFW-19, RFW-20, and RFW-24. Exploratory boring RFW-18 was drilled by case and wash techniques to 74 feet, where nested boulders made further drilling impractical. During the well construction of RFW-18, the borehole collapsed below 56.5 feet so that the well could not be finished below that depth. Figure 3-8 shows the locations of the seven wells at Site 15.

3.2.3.8 Subsurface Investigations at the Munitions Storage Area - Site 12

A power auger investigation was conducted at the MSA in areas of potential soil contamination resulting from past waste disposal. Four borings were installed in areas of stained ground or where waste solvents had reportedly been dumped (Figure 3-9). An HNu Model PI 101 photoionization detector was used to field screen soil samples for detectable volatile organic compounds. Three soil samples were taken for chemical analysis for TOX and O & G. The water table was not encountered during the investigation; therefore, no piezometers were installed. All borings were backfilled with native material at the completion of the investigation.

The statement of work authorized the sampling of two abandoned wells in the vicinity of the MSA, however, the wells could not be located and therefore no samples were obtained.

3.2.3.9 Subsurface Investigations at Zone 5: Landfill No. 6 - Site 6, and Construction Rubble Dump 2 - Site 17

As depicted in Figure 3-10, four monitoring wells were installed in Zone 5. RFW-32 was installed downgradient of CRD-2 to detect any hazardous substance that may be migrating into the wetlands bordering the site. The borehole was advanced to a depth of 17.5 feet, 1.5 feet into bedrock, and screened over the bottom 10 feet. Wells RFW-33, RFW-34, and RFW-35 were installed around the perimeter of LF-6 to assess any impacts it might have on the local groundwater and surrounding wetland. These wells were drilled to depths of 44, 24, and 49.5 feet, respectively. Bedrock was confirmed in RFW-32 by roller bit and in RFW-34 and RFW-35 by NX core barrel.

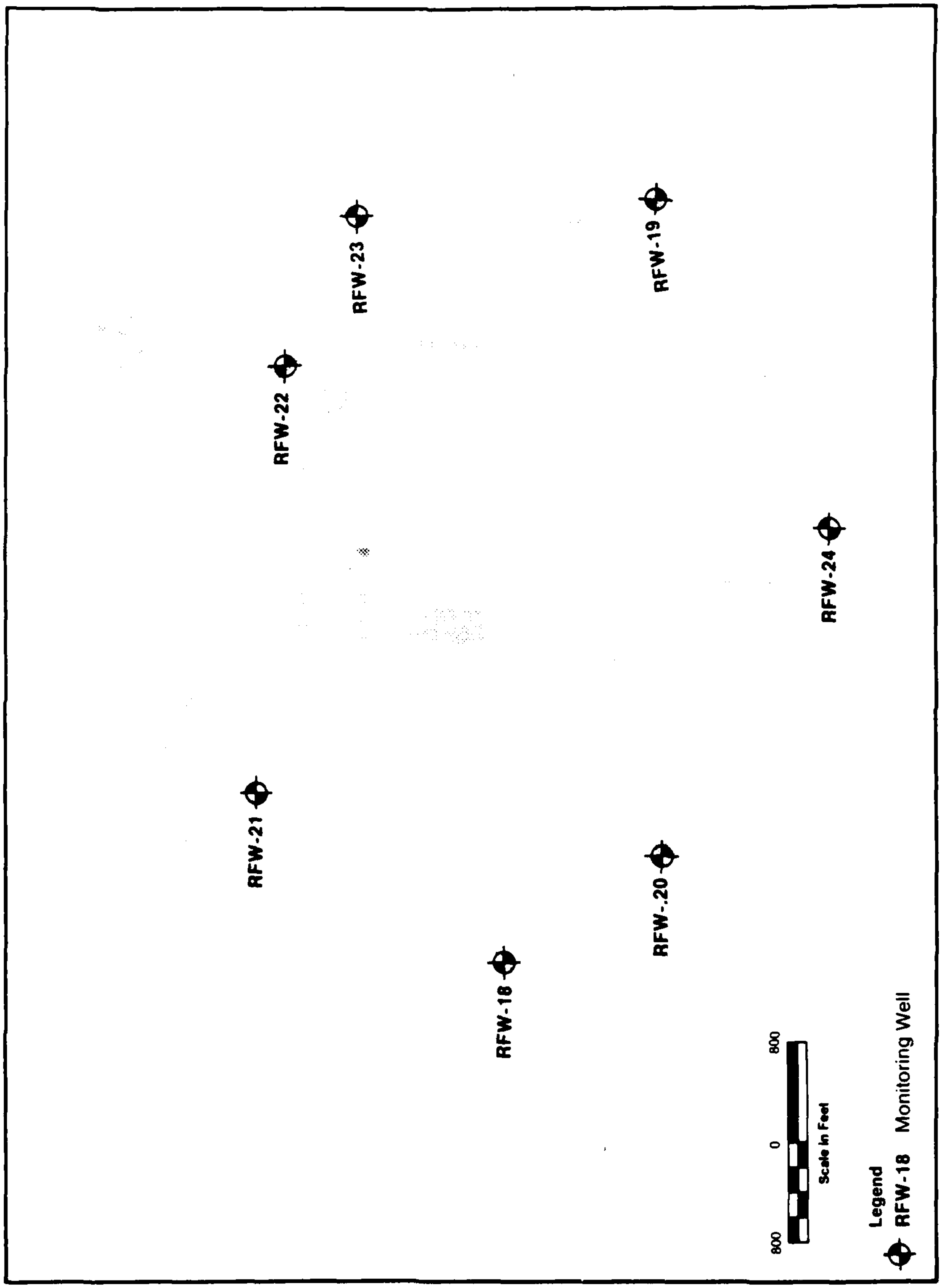


FIGURE 3-8 MONITORING WELL LOCATIONS IS/PA

WESTON

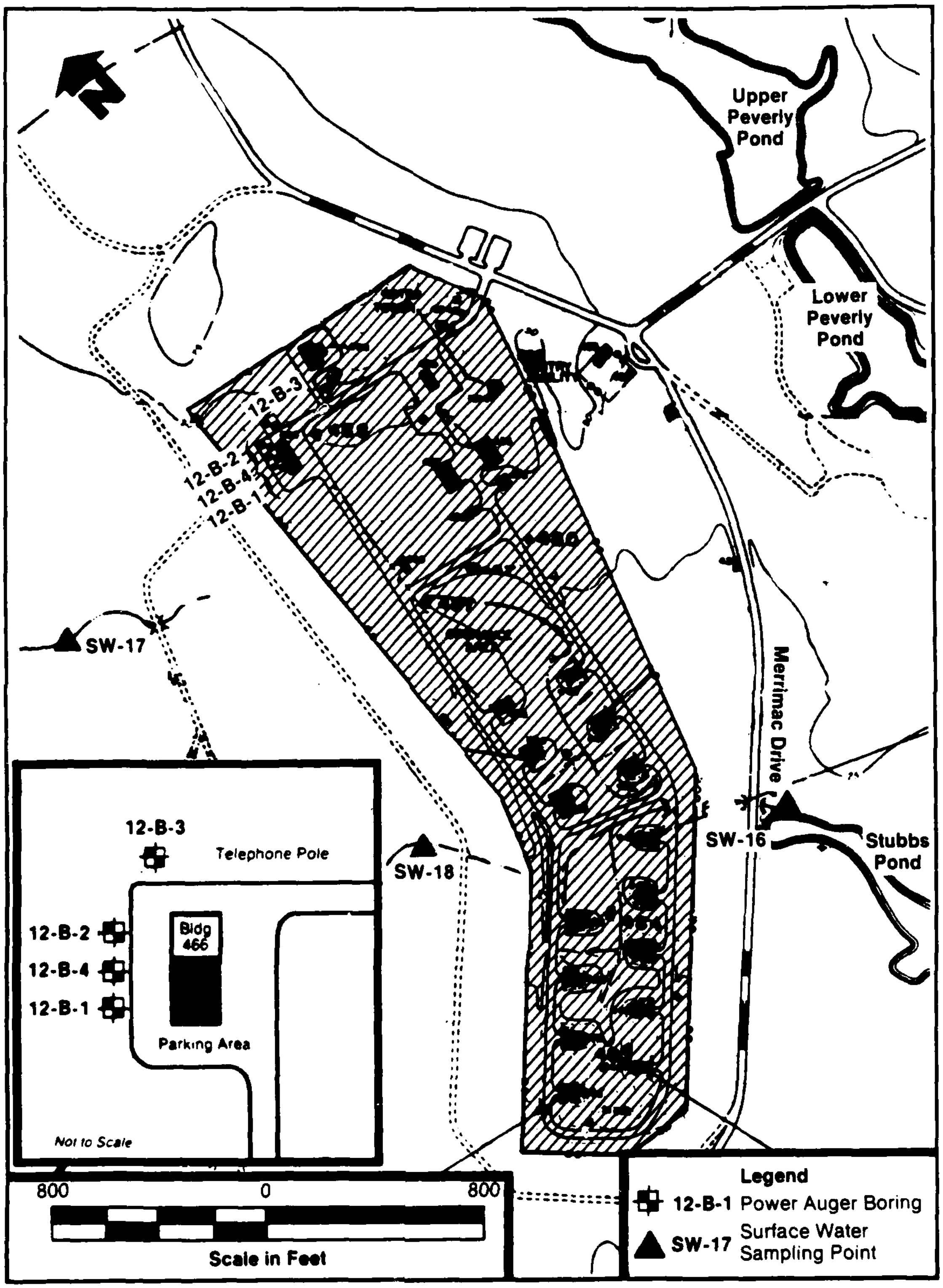


FIGURE 3-9 SURFACE WATER SAMPLING AND POWER AUGER BORING LOCATIONS FOR THE MSA

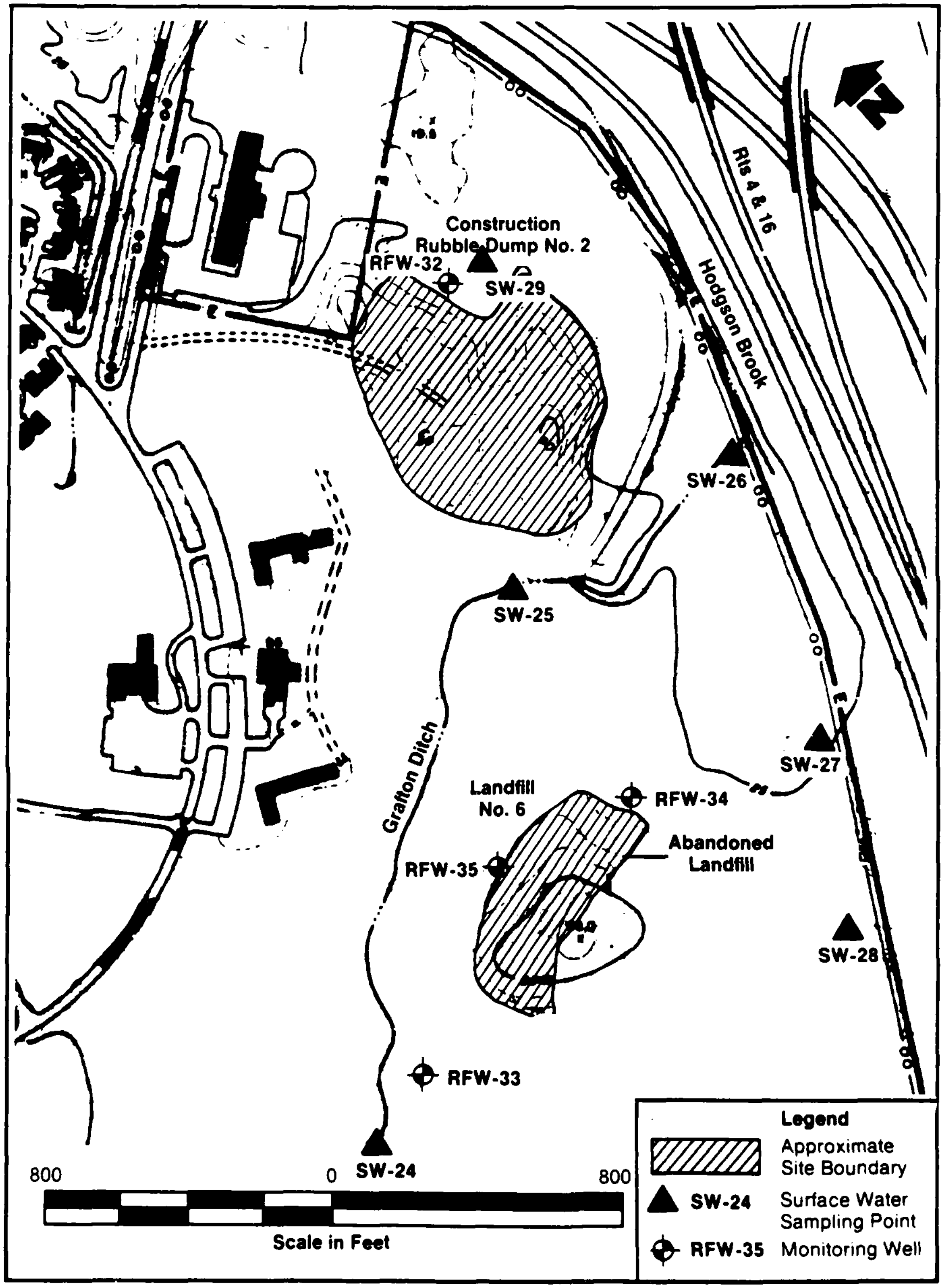


FIGURE 3-10 MONITORING WELL AND SURFACE WATER SAMPLING LOCATIONS AT LF-6 AND CRD2

3.2.3.10 Subsurface Investigations at the Leaded Fuel Tank Sludge Disposal Area - Site 10

The precise location of the sludge disposal site was not known at the outset of the investigation. To define the boundaries of the site, a geophysical survey was conducted. WESTON geoscientists employed Ground Penetrating Radar (GPR) in conjunction with a flux gate magnetometer to identify likely areas of concern. The geophysical techniques are described in Subsection 3.2.4.

Following completion of the geophysical survey, a test pit/power auger investigation was conducted to further define the extent of potential contaminant distribution at the LFTS. Four power auger borings were drilled in the areas of suspected waste disposal. The soil samples and ambient air were screened for detectable volatile organic compounds, using an HNu Model PI-101 photoionization detector. Four soil samples were retained for laboratory analysis. A backhoe was later used to excavate five test pits in the vicinity of an anomaly detected during the geophysical study.

During the backhoe study, a pocket of three buried drums was found at test pit locations 10-TP-4, 10-TP-5 and 10-TP-6. The HNu was used for screening purposes, and two samples of the sludge-stained soil were obtained from the area near the drums and were retained for laboratory analysis. Following the completion of the sampling phase of the investigation, the test pits were backfilled and regraded pending further study. The locations of the test pits and power auger borings are shown in Figures 3-11 and 3-12.

During the Phase II Stage 1 study, an area of stained soil and stressed vegetation was noticed in aerial photos in an area adjacent to and northwest of Site 10. The site appeared to have been a former burn area. Following the investigation at Site 10, the backhoe was moved to the newly found area, tentatively identified as Site 22, and four test pits were excavated. A single soil sample was retained for laboratory analysis from the area of highest field screening readings of soils with the HNu.

Using data collected during the Phase I background data search, as well as the Phase II geophysical, test pit, and power auger investigations three monitoring well locations were selected. Well RFW-26 was constructed to provide background water quality samples. Wells RFW-25 and RFW-27 were installed in estimated hydraulically downgradient positions from the LFTS and Site 22, respectively, to determine if the two sites are adversely impacting ground

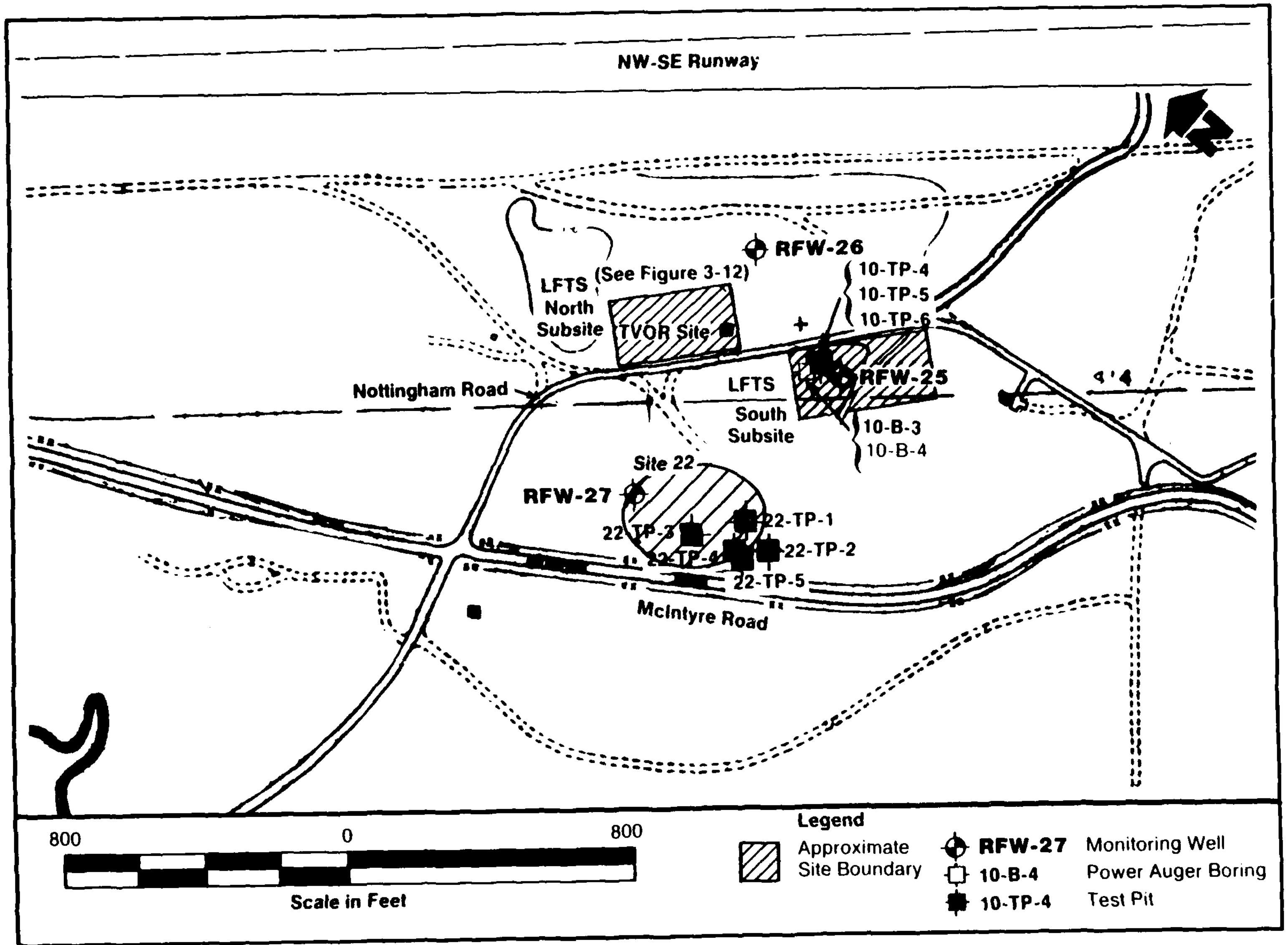


FIGURE 3-11 MONITORING WELL, TEST PIT, AND POWER AUGER BORING LOCATIONS, LFTS AND SITE 22

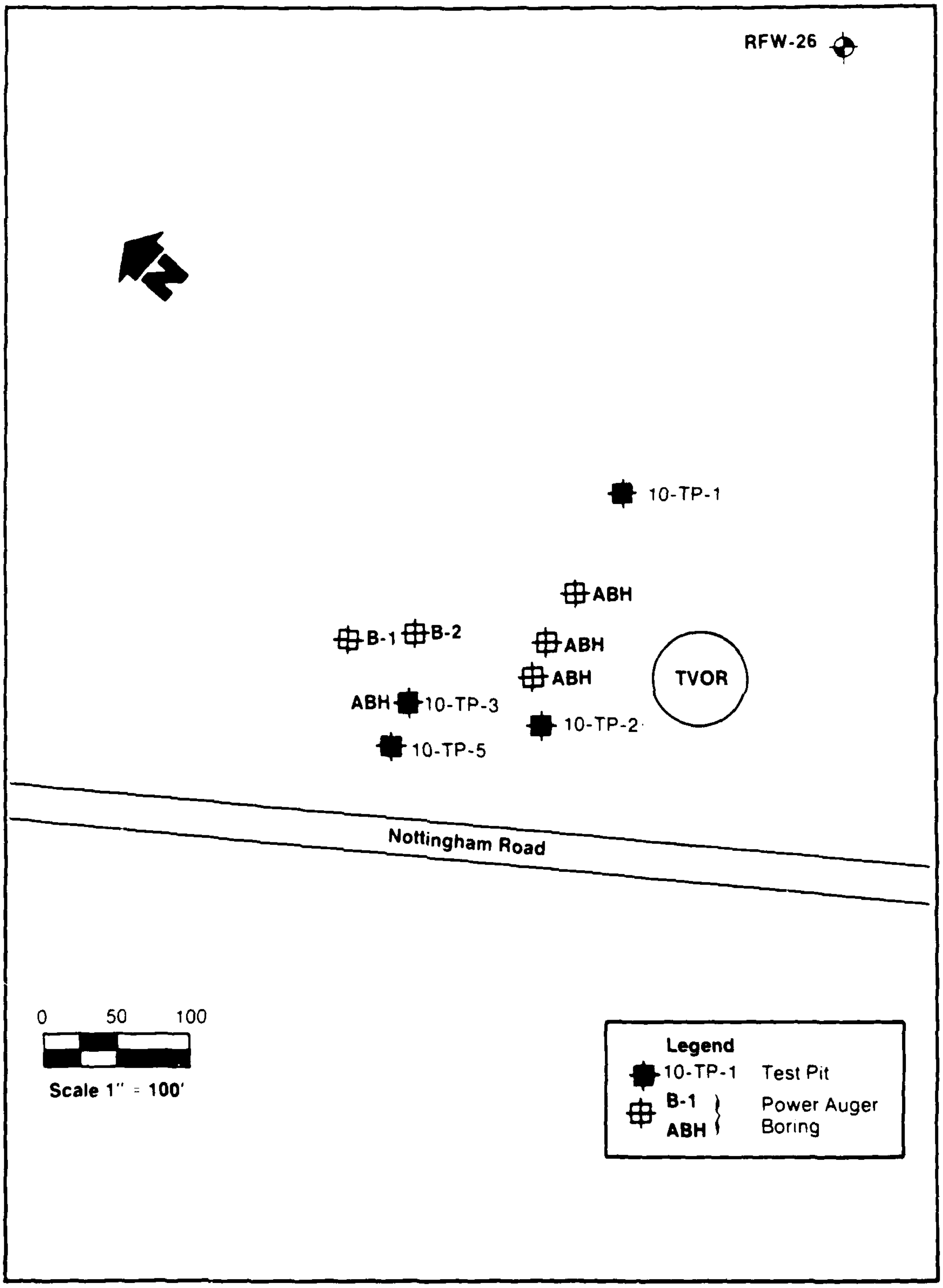


FIGURE 3-12 POWER AUGER BORINGS AND TEST PITS AT LFTS

water quality. The finished depths of the three wells range from 45 feet at RFW-27 to 62 feet at RFW-26. Bedrock was confirmed at each location by drilling approximately five feet with a roller bit. A five foot stratum of clay was encountered in RFW-26, from 39 to 44 feet below land surface. The well was screened from 44 to 62 feet below land surface to allow sampling of groundwater below the clay stratum. Soil samples taken from the upper five to ten feet of saturated thickness in wells RFW-25 and RFW-27 registered readings of up to 300 ppm on an HNu during the drilling operations. The borings were, therefore, screened over the entire saturated thickness to facilitate sampling of potentially contaminated zones.

3.2.3.11 Subsurface Investigations at Zone 6: The FMS Equipment Cleaning Site - Site 11, and Fuel Line Spill Site - Site 14

The FMS site is not a well-defined site and, in fact, may involve several disposal areas. Accordingly, a test pit investigation was conducted to better define the area of concern. Seven test pits were excavated at the locations shown on Figure 3-13. Four soil samples, including one QA/QC duplicate, were obtained for chemical analysis.

As with the FMS, the exact location of the FLS was not known. Four power auger holes were drilled to determine the most likely area for further investigation. The locations of the power auger holes are shown in Figure 3-13. Three soil samples were collected for analysis.

Two groundwater monitoring wells were installed in Zone 6, one at each site, to assess long-term impacts of the wastes discharged there as shown in Figure 3-13. RFW-16 was drilled at Site 11 to a depth of 31.5 feet. Bedrock was confirmed by advancing an NX core barrel five feet into bedrock. The well was screened over the entire saturated thickness of the aquifer. RFW-17 was installed at Site 14. Bedrock was encountered at 20.4 feet and confirmed by drilling an additional 4.6 feet with a roller bit. The well was screened from 10 to 25 feet below ground surface to allow sampling for potential floating hydrocarbons.

3.2.4 Geophysical Survey

A geophysical field investigation of the Leaded Fuel Tank Sludge Disposal Site (LFTS) was conducted by WESTON between 22 and 25 October 1984. The survey was performed with a

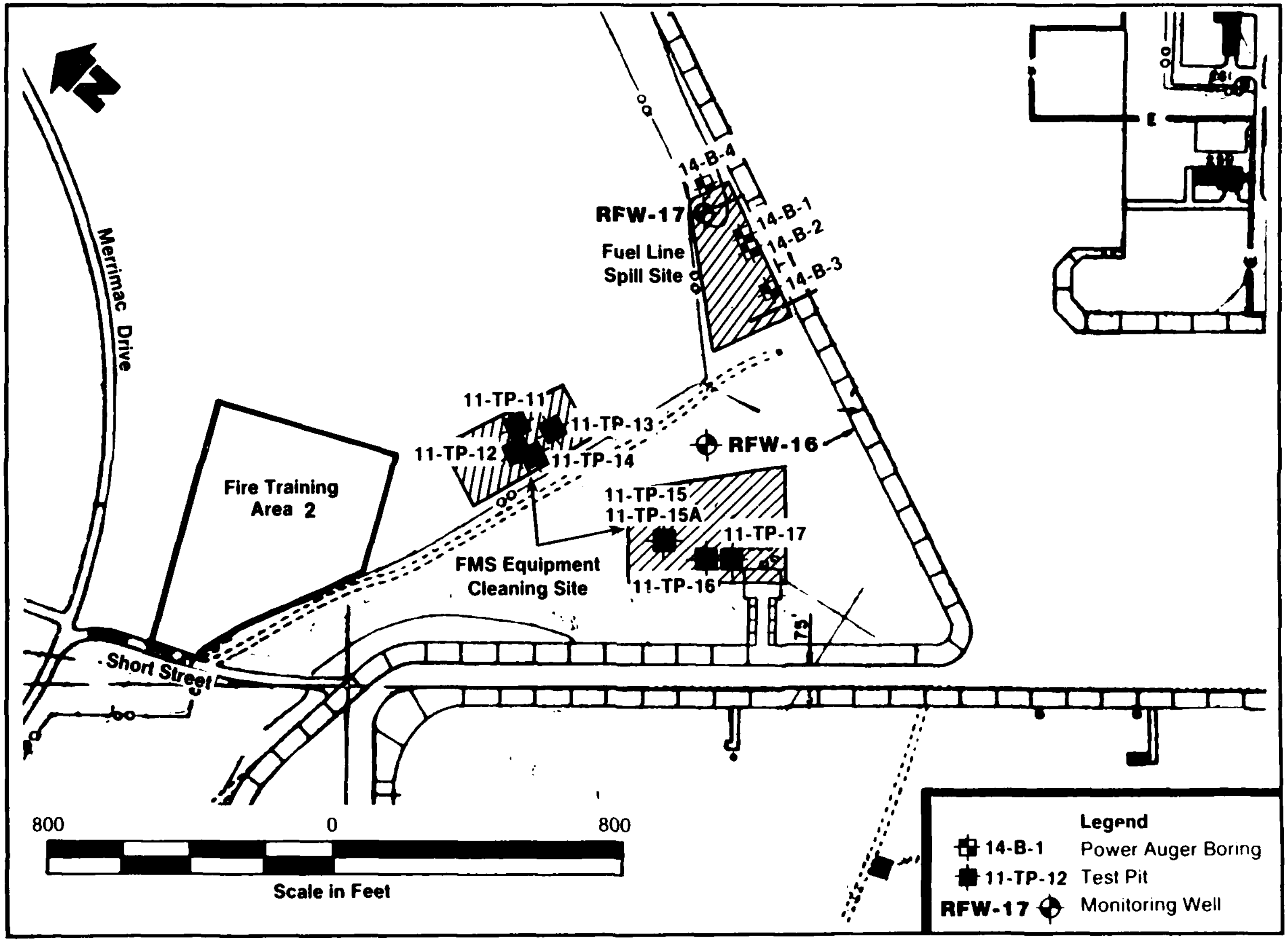


FIGURE 3-13 MONITORING WELL, TEST PIT, AND POWER AUGER LOCATIONS - FMS AND FLS

vertical field flux gate magnetometer and Ground Penetrating Radar (GPR). All magnetometer point readings and GPR traverses were referenced to a rectangular grid system staked out in the two areas of investigation as approximately shown in Figure 3-11.

3.2.4.1 Purpose of the Geophysical Survey

The purpose of the geophysical surveying program was to identify, insofar as possible at the level of a Confirmation Survey, the location, depth and areal extent of disturbed areas and buried ferromagnetic objects that may be associated with subsurface waste disposal.

The magnetometer data were used to develop a quantitative map of the distribution of magnetic anomalies which may be associated with buried metallic objects such as drums. The GPR survey provided qualitative information about subsurface features such as soil horizons, soil-bedrock interfaces, zones of saturation, disturbed areas, and buried objects. The two geophysical methods can be cross-referenced to enhance understanding of subsurface conditions. For instance, a buried object detected by GPR can be identified from the magnetic data as a nonmetallic boulder or a metallic drum. The geophysical methods used are reviewed in the following subsections. A discussion of the results of the geophysical survey is presented in subsection 4.2.

3.2.4.2 Magnetometer Survey at LFTS

The magnetometer survey was conducted with a Jolander vertical field flux gate magnetometer. Magnetic intensities were measured and recorded at fixed points in the survey grid. Readings were made at nodes of a 25-foot square grid in the south area and at nodes of a 50 x 25 foot rectangular grid in the north area. Because the magnetic intensity at any point will vary with the time of day, a reference point was established on site. Periodic readings were taken at this location during the survey. A curve was developed for magnetic variation with time and was used to adjust all data according to the time of day they were obtained.

3.2.4.3 Ground Penetrating Radar (GPR) Survey at LFTS

The GPR survey was conducted by WESTON using a GSSI System 8 Ground Penetrating Radar Unit. After establishing the survey grid, the next step was to calibrate the GPR system. To calibrate the system, either the dielectric constant

(E_r) of the survey medium, or the depth to a particular object or interface must be known. Calibration of the radar system was performed at the Pease AFB site using a two-step operation. Initial calibration was calculated using an assumed dielectric constant (E_r) of 12, based on on-site soil and moisture conditions. Next, for quality assurance purposes, calibration traverses were run over a 1-inch diameter conduit at a known depth of approximately 8 inches. From this calibration procedure a vertical depth profile scale of 1.0 inch = 2.0 feet was constructed.

Subsequent to the system calibration survey, traverses were conducted over the areas of concern. Continuous traverses were run across the sites and referenced to the established site grid. The product of the GPR Survey was a series of real-time subsurface graphic profiles. To standardize the data, identification marks were fixed on the profile for each traverse, at 25-foot intervals and grid intersections. Upon completion of the survey, data in the profiles were reduced for interpretation. The results of this analysis are presented in Subsection 4.2.2.

3.2.5 Field Testing

In order to maximize data collected from various types of field investigations at Pease AFB, a number of field testing techniques were employed. The field testing program involved: surveying locations and top-of-casing elevations of all monitoring wells and piezometers to provide water level elevation control; surveying locations of test pits and power auger borings; measuring water levels in all wells and monitoring *in situ* water quality data from all wells and surface water sampling locations, including pH, temperature, and specific conductance. Aquifer testing in the form of recovery and/or slug tests was performed wherever possible at monitoring well locations to estimate the hydraulic conductivity. Methods used in each phase of field testing are described below.

3.2.5.1 Surveying

In May 1985, WESTON personnel conducted a field survey of wells, piezometers, test pits, and power auger borings. A Dietzgen Top-Site Model 6140 30-second transit was used to determine horizontal locations to an accuracy of $\pm$ 10 feet. A Kern Automatic Level was used to determine elevations to an accuracy of $\pm$0.05 feet. The National Geodetic Vertical Datum (NGVD) was used as the basis for all

survey work. Locations and elevations of benchmarks used during the survey were supplied by the base Civil Engineering Department. At all wells, the data measured included horizontal location, top of PVC casing, top of steel casing, and ground elevation; at temporary piezometers the data included the horizontal location, top of PVC, and ground elevation; and at the test pits and power auger holes, only horizontal location was recorded. In areas where several test pits or power auger holes were located, a permanent marker was installed, and all the locations were established from that point.

Permanent markers were placed at all surface water and sediment sampling locations. These markers consisted of galvanized metal pipe, painted fluorescent orange, and driven into the ground at the appropriate locations. A copper cap was placed over the end of the pipe and stamped with an identification number.

3.2.5.2 Water Level Measurements

Prior to collecting each of the two rounds of well water samples, groundwater elevation measurements were made at each well using a Soil Test Model DR-760A Water Level Probe. Table 3-5 provides a summary of monitoring well survey and water level data.

3.2.5.3 Field Water Quality Testing

Two rounds each of surface water and groundwater samples were collected at Pease AFB. In addition to the samples retained for laboratory analysis, *in situ* measurements were made for pH, temperature, and specific conductance. A Yellow Springs Instrument Company Model 33 SCT meter was used to measure specific conductance and temperature. An Analytical Measurement Model 107 pH meter was used to measure pH.

A single measurement was taken at each surface water sampling point. During well sampling, a series of at least three readings were taken as the well was purged prior to sampling. It was therefore possible to determine when readings had stabilized, indicating that a representative aquifer sample was being taken.

During all sampling activities, an HNu Model PI-101 photoionization meter was used to screen the ambient air for volatile organic compounds. During well sampling

Table 3-5

SUMMARY OF MONITORING WELL SURVEY
AND WATER LEVEL DATA

Location	Well	Ground Surface Elevation (MSL)	Elevation Top of PVC Casing	Depth To Water(1) 3/19/85	Water Table Elevation 4/3/85	Depth To Water(1) 4/29/85	Water Table Elevation 5/7/85
Bulk Fuel Storage Area	RFW-1	81.52	83.92	9.92	74.00	12.54	71.38
	RFW-2	88.03	89.93	12.79	77.14	14.21	75.72
	RFW-3	99.63	102.12	14.16	87.96	17.10	85.02
	RFW-4	108.41	110.59	8.00	102.59	10.19	100.40
Landfills No. 2-5	RFW-5	97.90	99.70	12.77	86.93	13.33	86.37
	RFW-6	83.70	85.55	5.46	80.09	6.17	79.38
	RFW-7	61.88	64.41	3.65	60.76	6.46	57.95
	RFW-8	71.44	73.37	3.04	70.33	5.52	67.85
	RFW-9	45.03	47.52	2.50	45.02	4.15	43.37
Fire Department Training Area No2	RFW-10	113.14	115.20	26.75	88.45	26.48	88.72
	RFW-11	114.86	117.28	---	---	28.29	88.99
	RFW-12	116.98	119.30	28.42	90.88	29.58	89.72
	RFW-13	111.66	114.12	23.29	90.83	24.94	89.18
	RFW-14	110.72	112.26	12.88	99.38	18.67	93.59
	RFW-15	108.09	110.12	12.88	97.24	16.21	93.91
FMS Equipment Cleaning Site	RFW-16	108.43	110.10	16.92	94.18	16.94	94.16
Fuel Line Spill Site	RFW-17	97.57	99.70	11.98	87.72	12.85	86.85
Industrial Shop/ Parking Apron Zone	RFW-18	88.46	88.31	16.92	71.39	17.38	71.08
	RFW-19	70.29	70.21	20.04	50.17	20.44	49.77
	RFW-20	86.72	86.61	6.96	79.65	7.77	78.84
	RFW-21	72.63	72.49	8.71	63.78	8.79	63.70

Table 3-5 (cont'd)

Location	Well	Ground Surface Elevation (MSL)	Elevation Top of PVC Casing	Depth To Water(1) 3/19/85	Water Table Elevation 4/3/85	Depth To Water(1) 4/29/85	Water Table Elevation 5/7/85
Industrial Shop/Parking Apron Zone	RFW-22	59.07	61.26	4.73	56.53	6.92	54.34
	RFW-23	55.97	58.14	9.42	48.72	11.17	46.97
	RFW-24	65.73	68.00	20.62	47.38	21.33	46.67
Leaded Fuel Tank Sludge Disposal Site	RFW-25	100.89	102.86	19.88	72.98	22.25	80.61
	RFW-26	109.02	111.45	32.55	78.90	33.17	78.28
	RFW-27	106.39	108.35	30.21	78.14	22.52	85.83
Fire Department Training Area No.1	RFW-28	95.22	97.29	22.98	74.31	22.10	75.19
Landfill - No. 1	RFW-29	41.64	43.93	9.10	34.83	8.67	35.26
	RFW-30	89.52	91.92	17.54	74.38	16.52	75.40
	RFW-31	56.06	58.12	10.67	47.45	10.67	47.45
Construction Rubble Dump No. 2	RFW-32	23.93	26.09	1.79	24.30		
Landfill No. 6	RFW-33	34.93	37.17	3.12	34.05	2.50	34.67
	RFW-34	33.48	35.87	2.52	33.35	2.08	33.79
	RFW-35	38.10	40.27	8.54	31.73	7.10	33.17

(1) Measured from top of PVC casing
-- No measurement taken.
All data reported in feet.

activities, the head space of the well casing and an agitated water sample were also screened. The results were recorded in a field log book. A summary of the field water quality data is presented in Table 3-6.

3.2.5.4 Aquifer Testing

In situ permeability tests, or "slug tests" were performed on 32 of the 35 new monitoring wells installed in this investigation. Slug tests involved either introducing or removing a slug of water into or from the well in a manner as close to instantaneous as possible, and observing associated water level changes in the well as it returns to equilibrium with the surrounding aquifer. The test is designed to estimate hydraulic conductivity of aquifer materials in the immediate vicinity of the screened interval of the well. Test methods followed guidelines developed by the U.S. Navy, Naval Facilities Engineering Command, and described by Cedergren (1977). The essential steps are listed as follows:

- The static water level in the well to be tested was measured.
- Water was either pumped from (recovery test) or into (slug test) the well. In the former case, an attempt was made to evacuate the entire well; in the latter, the casing was filled to the top of the pipe.
- As the water level returned to the static position, the elapsed time and the water level readings were recorded until the level returned to at least 90 percent of the static level.

Further discussion of the significance of the slug tests results is provided in Subsection 4.1.

3.2.6 Tank Sampling

As required in the Task Order (Appendix B, Section 4E), a survey of abandoned waste storage tanks was conducted. Two tanks were identified in the Industrial Shop/Parking Apron Area, one adjacent to Building 244 (tank T-1) and one adjacent to Building 113 (tank T-2). Both tanks are discussed in the Phase I study and were reportedly used as holding tanks for waste trichloroethylene used in vapor degreasing operations.

TABLE 3-6

SUMMARY OF BASE-WIDE IN SITU WATER QUALITY DATA

WELL NO.	Temperature °C 3/19-4/5/85	Temperature °C 4/29-5/7/85	Specific Conductance umhos/cm 3/19-4/5/85	Specific Conductance umhos/cm 4/29-5/7/85	pH 3/19-4/5/85	pH 4/29-5/7/85
RFW 1	10.0	9.0	220	255	7.0	7.0
RFW 2	9.0	10.0	430	460	7.2	7.0
RFW 3	8.0	9.0	130	110	8.1	7.6
RFW 4	8.0	9.0	110	110	6.6	6.8
RFW 5	6.0	10.0	150	110	8.2	7.6
RFW 6	6.0	8.0	160	150	6.2	6.2
RFW 7	7.0	10.0	380	420	7.0	7.0
RFW 8	9.0	10.0	220	110	11.2	9.0
RFW 9	9.0	10.0	250	290	7.4	7.5
RFW 10	8.0	10.0	150	140	8.4	6.5
RFW 11	8.0	12.0	130	450	7.2	6.5
RFW 12	9.0	10.0	360	160	6.8	6.8
RFW 13	9.0	11.0	90	180	6.0	6.8
RFW 14	8.0	11.0	60	100	6.5	6.2
RFW 15	7.0	11.0	80	90	6.8	6.8
RFW 16	6.0	9.5	25	80	5.8	6.7
RFW 17	6.0	9.0	90	40	7.0	6.2
RFW 18	8.0	10.0	230	230	7.0	7.0
RFW 19	7.0	11.0	190	160	6.4	6.0
RFW 20	7.0	8.0	40	35	6.0	5.8
RFW 21	10.0	11.5	140	160	7.5	6.8
RFW 22	4.0	9.0	180	185	7.6	6.6
RFW 23	7.0	9.0	160	155	6.7	6.8
RFW 24	9.0	9.0	190	175	7.9	7.4
RFW 25	10.0	8.5	110	105	6.5	6.0
RFW 26	8.0	9.0	160	160	8.6	7.9
RFW 27	9.0	9.0	80	110	6.2	7.6
RFW 28	10.0	9.0	140	135	8.2	8.4
RFW 29	9.0	10.0	750	750	7.6	6.4
RFW 30	8.5	8.5	140	115	7.2	6.5
RFW 31	9.0	10.0	600	650	6.7	5.7
RFW 32	10.0	10.0	1000	1000	5.0	6.0
RFW 33	8.0	10.0	330	250	8.0	9.0
RFW 34	8.0	10.0	1200	1400	7.2	7.3
RFW 35	10.0	10.0	1200	1200	6.5	6.5

TABLE 3-6

SUMMARY OF BASE-WIDE IN SITU WATER QUALITY DATA

Surface Water Location (1)	Temperature °C 11/7-11/9/85	Temperature °C 4/29-5/7/85 3/11-4/5/85	Specific Conductance umhos/cm 11/7-11/9/85	Specific Conductance umhos/cm 4/29-5/7/85 3/11-4/5/85	pH 11/7-11/9/85	pH 4/29-5/7/85 3/11-4/5/85
SW- 1	5.5	5.0	310	230	7.5	7.4
SW- 2	6.0	7.0	550	160	6.6	6.8
SW- 3	3.0	6.0	285	370	6.6	7.2
SW- 4	3.0	7.2	270	180	6.8	7.2
SW- 5	5.0	----	330	----	7.1	----
SW- 6	5.0	6.0	340	150	7.0	7.2
SW- 7	4.0	8.0	485	290	6.8	6.8
SW- 8	6.0	5.0	255	108	7.5	7.4
SW- 9	2.0	6.0	210	100	7.6	7.6
SW-10	9.0	10.0	810	490	6.8	7.4
SW-11	7.0	7.0	450	250	6.2	6.6
SW-12	8.0	7.0	435	220	6.4	6.8
SW-13	9.5	7.0	190	30	6.6	6.2
SW-14	10.0	8.0	190	140	6.8	7.4
SW-15	9.0	7.0	180	120	6.6	7.6
SW-16	5.0	5.0	175	50	6.7	6.6
SW-17	10.0	2.0	50	30	6.9	7.0
SW-18	8.0	2.0	100	30	6.2	6.5
SW-19	9.5	6.0	300	150	6.8	7.2
SW-20	10.0	6.0	300	156	7.2	6.5
SW-21	13.0	2.5	280	70	6.7	7.0
SW-22	13.0	3.5	1550	155	6.8	6.8
SW-23	13.0	----	275	----	6.7	----
SW-24	10.0	3.0	865	40	6.9	5.0
SW-25	7.0	6.0	720	440	6.4	6.9
SW-26	5.5	1.0	780	330	6.4	6.2
SW-27	6.0	3.0	830	250	6.4	7.2
SW-28	4.0	1.0	895	700	6.3	6.0
SW-29	4.5	2.0	100	800	6.1	7.2
SW-30	8.0	4.5	390	130	7.0	5.8
SW-31	7.0	4.0	400	370	7.4	7.4

--- Parameters not measured.

(1) SW-5 and SW-23 were QA/QC trip blanks during sampling Round No. 1, SW 32, 33, and 34 were Round 2 QA/QC duplicates.

Table 3-6 (cont.)

SUMMARY OF BASE-WIDE IN SITU WATER QUALITY DATA

Production Well Location	Temperature °C		Specific Conductance umhos/cm		pH	
	11/7/84	3/13/85	11/7/84	3/13/85	11/7/84	3/13/85
PW-1 (Smith)	9.0	9.0	160	180	7.6	8.0
PW-2 (Harrison)	10.0	9.0	235	260	7.1	7.1
PW-3 (Haven)	10.5	10.0	240	260	7.3	7.5
PW-4 (MMSI)	7.0	10.0	340	300	6.3	7.6
PW-5 (MMS2)	10.0	10.0	210	220	7.6	9.0
PW-6 (Loomis)	9.0	10.0	240	250	7.3	6.8

Tank T-1 is located adjacent to the southeast corner of Building 244. It is constructed of concrete and measures approximately four feet deep by ten feet long by six feet wide. The Phase I Report stated that all liquid had been removed from the tank, however, at the time of sampling, the tank contained approximately four and one half feet of liquid. Two cast iron pipes were observed entering the tank from the north and west sides, respectively.

Tank T-2 is located adjacent to the northeast corner of Building 113. Its construction is similar to that of T-1 and it measures approximately six feet by four feet with an undetermined depth. As noted in the Phase I Report, the tank was partially filled with sand; however, the sand was saturated to a depth approximately two feet below the top of the sand.

The two tanks were sampled on 24 April 1985 by WESTON personnel. Duplicate samples were obtained and sent to the WESTON and USAFOEHL Laboratories for chemical analysis. A liquid sample was collected from T-1, a sample of saturated sand was collected from T-2.

3.2.7 Groundwater Quality Sampling

Two complete rounds of groundwater samples were collected from the 35 monitoring wells installed at Pease AFB. The first round was collected between March 19 and April 5, 1985; the second round was collected between April 29 and May 7, 1985. Two rounds of samples were also collected from the six water supply wells on base, during the surface sampling program; the first on November 11, 1984, and the second on March 13, 1985. Due to sampling and laboratory QA requirements regarding holding times, analytical methods, and detection limits, additional sampling was performed to complete the analytical protocol for the Task Order. The additional samples were collected in December 1985 and January 1986.

Three abandoned wells, those described in Section 3.2.3.8 and two additional wells in the vicinity of the CRD-1 were authorized to be sampled but were not located in the field and, therefore, were not sampled.

Water samples from each well were packaged and preserved according to analyses required at that location and outlined in Table 3-1. Groundwater sampling locations at each site

were described in Subsections 3.2.3.4 through 3.2.3.11. above.

The purpose of the water quality sampling program was to identify, insofar as possible at the level of a confirmation survey, the location, concentration and areal extent of any contamination present in the hydrogeologic environment. From this information it would be possible to deduce the general direction in which these contaminants are migrating and their probable origin. To achieve these goals efficiently, specific field procedures were followed for purging the wells, collecting the samples, and ensuring field quality control. These procedures have been used to obtain representative samples for chemical analysis from monitoring wells and surface water streams. The sampling and quality assurance plans used to accomplish these goals are contained in Appendix F.1. Standard laboratory analytical protocols used in the analysis of these samples are contained in Appendix F.2.

3.2.8 Surface Water and Sediment Sampling

In temperate climates there generally exists an intimate relationship between groundwater and surface water. Groundwater discharging to streams and rivers provides the base flow during dry periods. Accordingly, contaminated groundwater or landfill leachate may adversely impact surface water. To assess this potential at Pease AFB a surface water sampling protocol was undertaken. A total of 29 surface water sampling locations were identified and sampled on two occasions. Concurrently with the surface water program, sediment samples were collected at six locations. All stream sampling locations were permanently marked in the field with galvanized steel poles.

As part of the sampling QA/QC program, distilled water trip blanks were assigned surface water sample numbers and shipped with the field samples. A duplicate sediment sample was also collected and analyzed for QA/QC purposes. A complete description of the sampling, packaging, and quality assurance procedures is included in Appendix E. Sample chain-of-custody documentation is found in Appendix F and laboratory analytical protocols are included in Appendix H. Site sample locations are discussed below and the significance of the analytical results is discussed in Subsection 4.4.

3.2.8.1 Surface Water Investigation at Zone 1, Bulk Fuel Storage Area - Site 13, and Landfills No. 2, 3, 4 & 5 - Sites 2, 3, 4 and 5

Eight surface water monitoring points were designated to address the issue of possible surface water degradation by discharge of potentially contaminated groundwater and/or leachate discharging to Pauls Brook and Flagstone Brook. The eight sites, shown in Figure 3-5, were selected to provide representative water quality data upstream of the zone, adjacent to each site within the zone, and remotely downstream. Changes in water quality through the zone could then be addressed on a site-by-site basis, and the remote sampling data could be used to assess the potential for off-base migration of wastes.

3.2.8.2 Surface Water Investigations at Zone 2: Fire Department Training Area No. 1 - Site 7, and Landfill No. 1 - Site 1

Upper and Lower Peverly Ponds are located adjacent to LF-1 and serve as a recreational facility for base personnel, providing access for fishing, swimming, and camping. Their proximity to Zone 2 makes them subject to possible contamination from surface runoff and leachate breakouts from LF-1, and potentially contaminated groundwater flow from either LF-1 or FDTA-1. Four surface water locations were sampled and analyzed for suspect contaminants and are shown in Figure 3-6.

The sample locations shown in Figure 3-6 provided water quality data upstream of the zone, adjacent to LF-1, in Lower Peverly Pond, and remotely downstream of the zone in the pond called Bass Pond.

3.2.8.3 Surface Water Investigations at Zone 4: Grafton Ditch, Newfield Ditch, and McIntyre Brook - Sites 19, 20 and 21

An unknown quantity of potentially hazardous materials has reportedly been discharged to base storm sewers. Further potential contamination from spilled petroleum products and other materials may have been carried into the storm drainage system by rainfall runoff. To determine if these past incidents continue to pose any environmental threats, the receiving streams were sampled. Surface water and sediment from Grafton Ditch, Newfields Ditch, and McIntyre Brook were each sampled at two locations on two occasions to monitor water quality changes with distance from the

outfalls and to determine whether or not waste is migrating off-base. Figures 3-14, 3-15 and 3-16 respectively, show approximate locations of all sampling sites.

3.2.8.4 Surface Water Investigation at the Munitions Storage Area - Site 12

Disposal of solvents used at this site may have resulted in the contamination of two unnamed tributaries to Great Bay. Samples were collected from each of the two streams (locations shown in Figure 3-9) and analyzed for the appropriate parameters (Table 3-1) on two occasions.

3.2.8.5 Surface Water Investigations at Construction Rubble Dump No. 1 - Site 9

This site, located adjacent to an unnamed tributary to Upper Peverly Pond, allegedly received small quantities of waste solvents. If discharged to the stream, these solvents could pose a potential threat to the water quality of the ponds. Therefore, three surface water samples were collected at the locations shown in Figure 3-17, to evaluate water quality at the base boundary, adjacent to site CRD-1 and remotely downstream.

3.2.8.6 Surface Water Investigations at Zone 5: Landfill No. 6 and Construction Rubble Dump No. 2

This zone is bordered on three sides by wetlands and lies in close proximity to the base boundary. A stream flowing between the two sites and discharging off-base could be acting as a conduit for migration of contamination beyond the base boundary. Six surface water samples were taken at the locations shown in Figure 3-10 and analyzed for pertinent parameters to determine if potential contamination from this zone was impacting the wetland and/or migrating off-base.

3.3 INVENTORY OF ALL WELLS (ACTIVE, INACTIVE, ABANDONED MONITORING, ETC.), ON BASE

As required by the Task Order (Appendix B), an inventory of all wells on base was conducted by WESTON field personnel. Table 3-7 is a compilation of available data concerning these wells and Figure 3-18 shows approximate locations of those wells that could be located. Also the monitor wells installed during the Phase II Stage 1 investigation are included on Figure 3-18. Sources of the information included Pease AFB personnel, The University of New

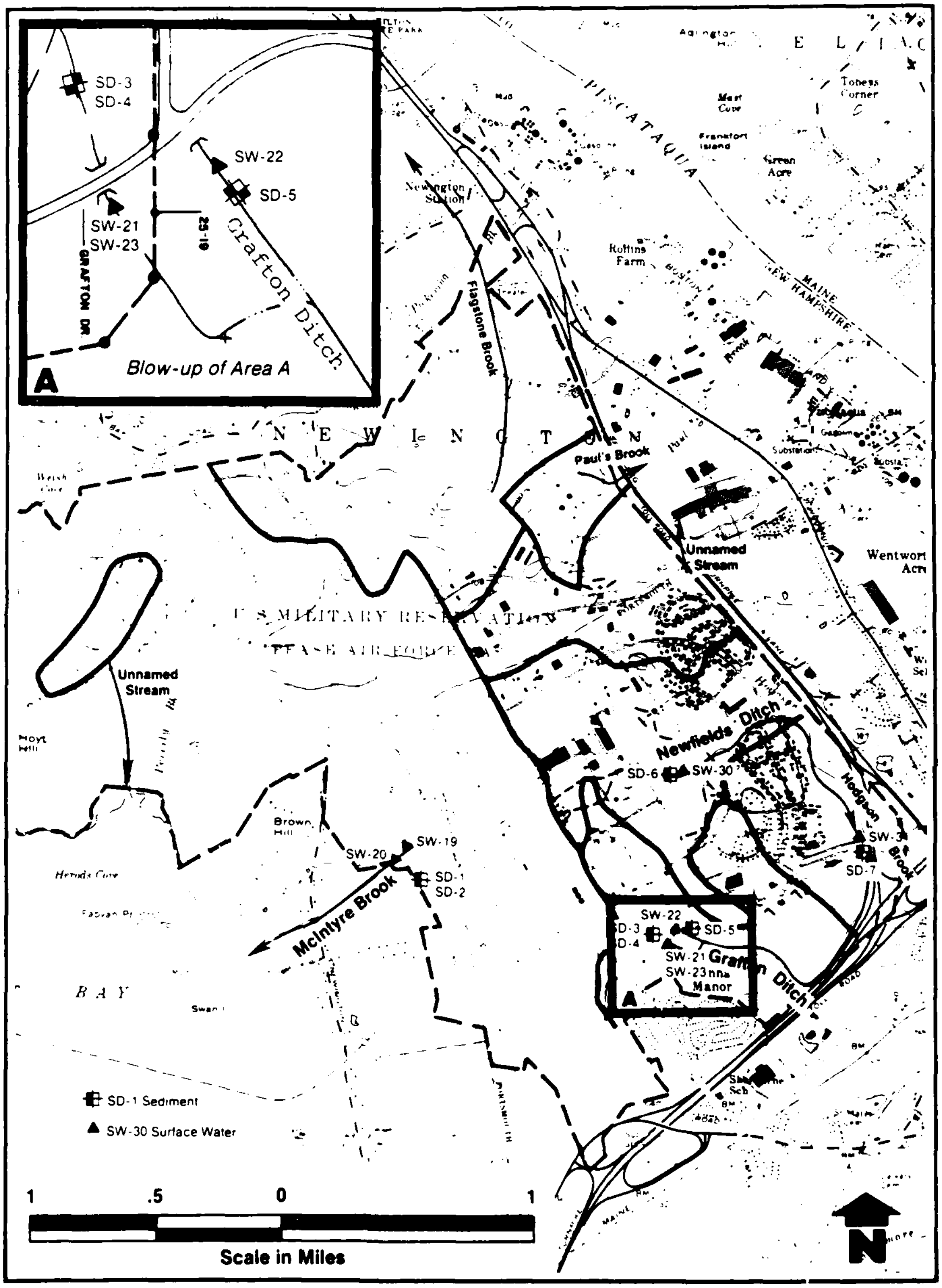


FIGURE 3-14 LOCATION OF SEDIMENT AND SURFACE WATER SAMPLING POINTS - GRAFTON DITCH

WESTON

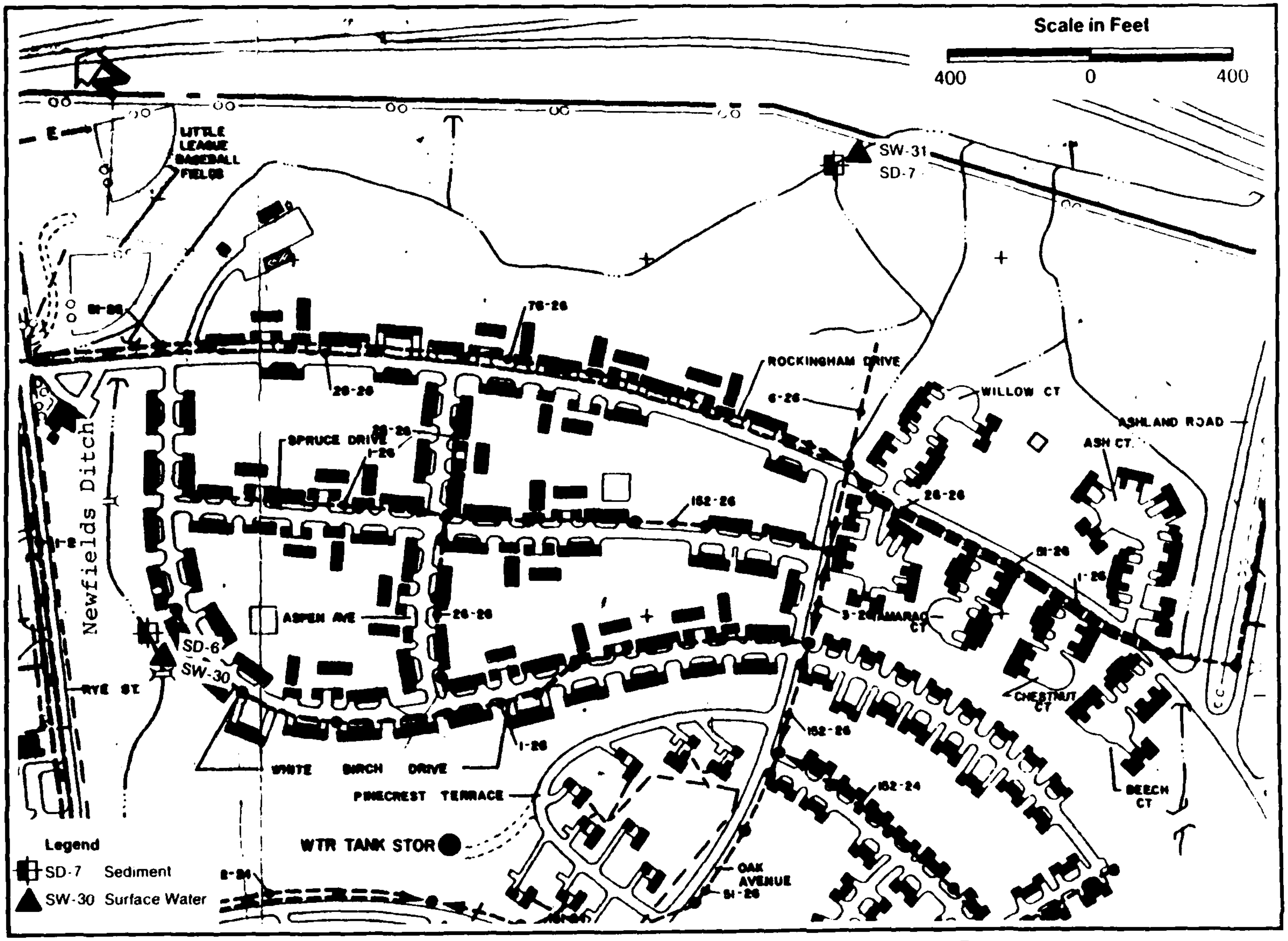


FIGURE 3-15 LOCATION OF SEDIMENT AND SURFACE WATER SAMPLING POINTS - NEWFIELDS DITCH

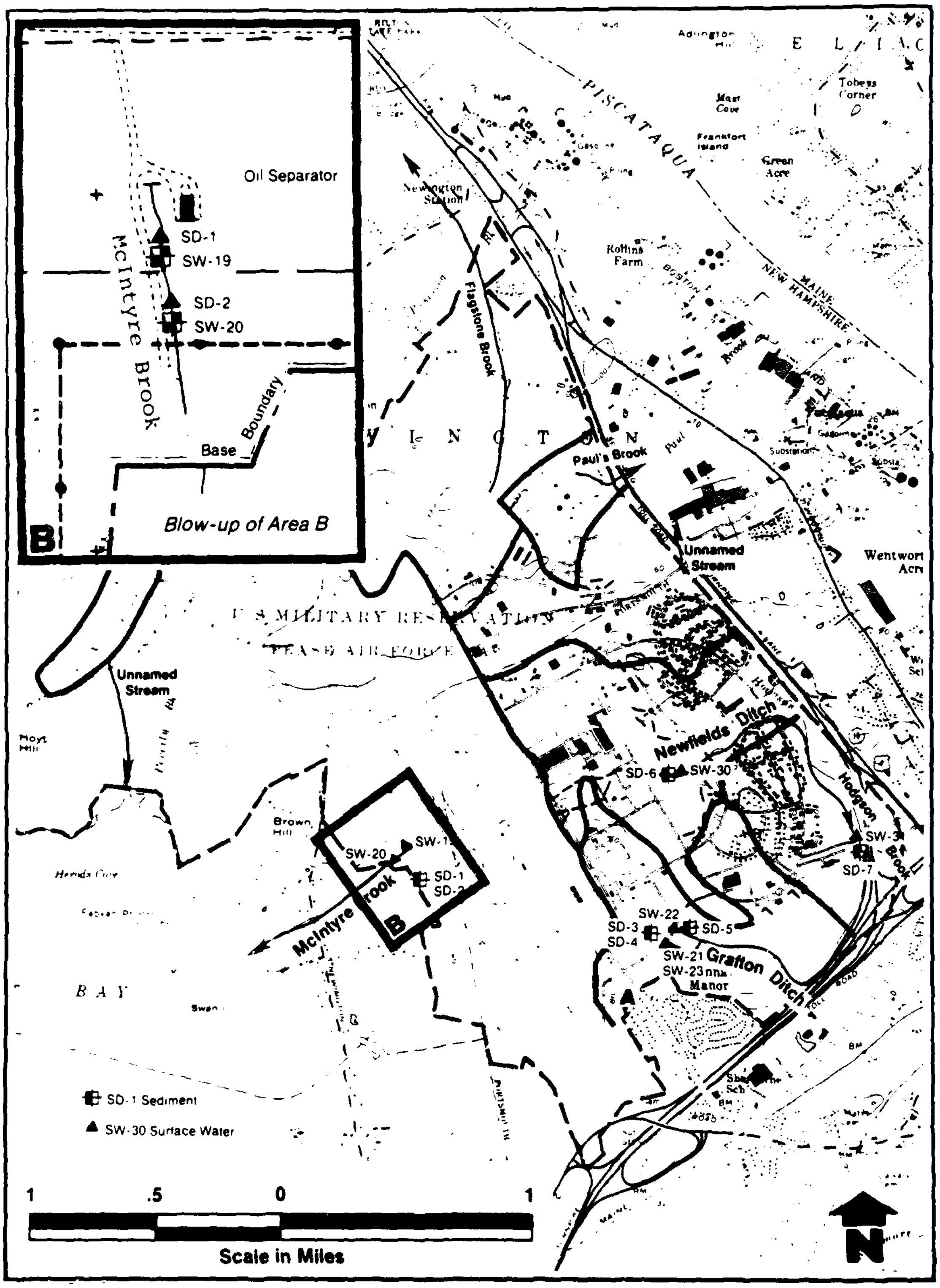


FIGURE 3-16 LOCATIONS OF SEDIMENT AND SURFACE WATER SAMPLING POINTS - MCINTYRE BROOK

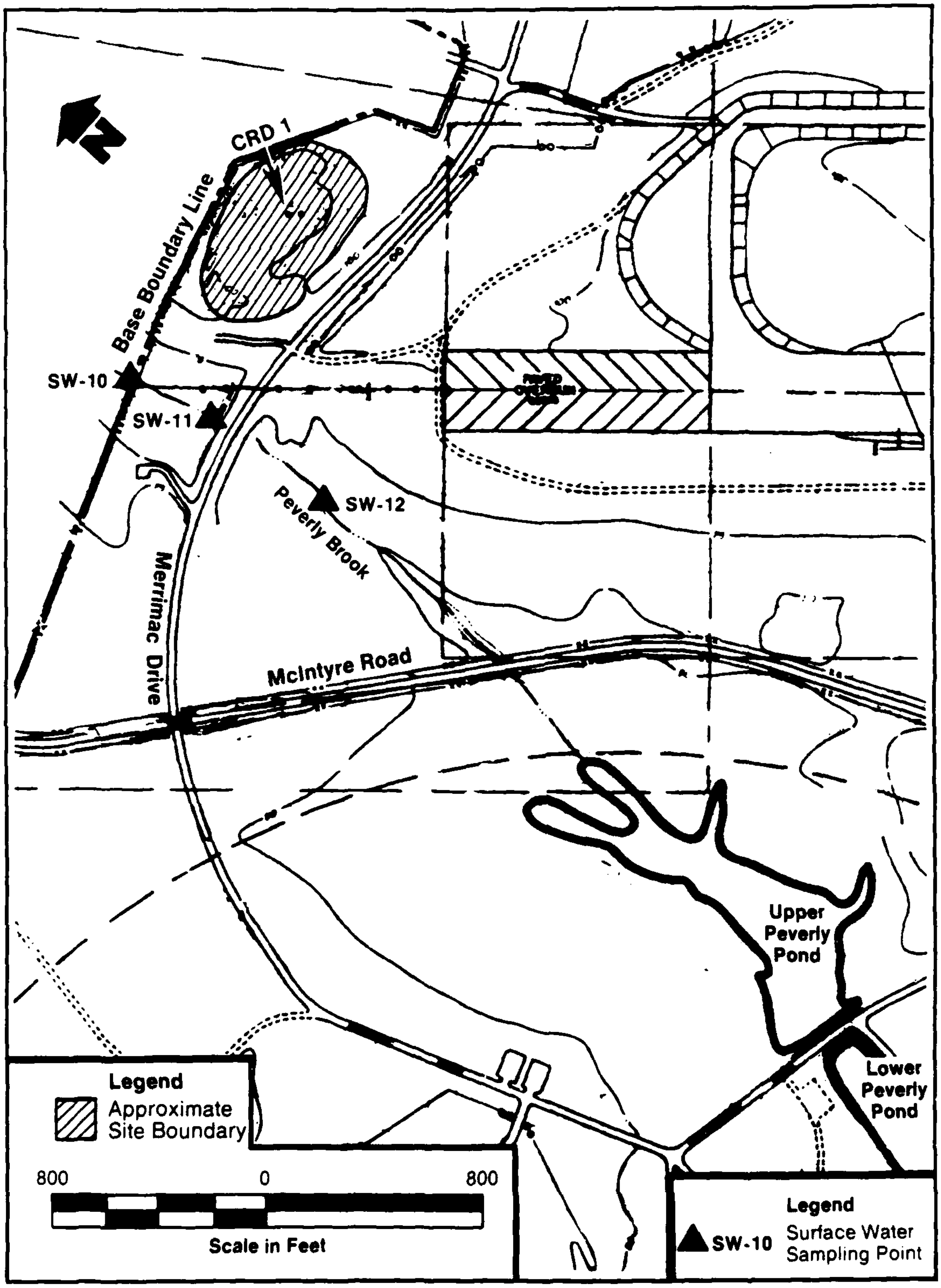


FIGURE 3-17 SURFACE WATER SAMPLING LOCATIONS CRD1

Table 3-7

SUMMARY OF DATA FOR INACTIVE WELLS AT PEASE AFB

Well Identification	Depth of Boring	Well Construction	Use	Static Water Level (Feet) DAR	SWL	DAR	SWL	Yield (gpm)	Type	Native Material	Date Completed	Remarks
B-100	46 ft.		O.W.					(gpm)		SAND, CLAY, SILT & Bedrock	1/7/58	
B-101	77 ft.		O.W.	1/23/58	39.4'	2/3/58	38.3'			silty SAND	1/7/58	
B-102	86 ft.		O.W.							gravelly SAND, GRAVEL & SAND	1/18/58	
B-103	46 ft.		O.W.	1/28/58	39.1'	2/3/58	36.7'			silty SAND, gravelly SAND, refusal	1/25/58	
B-104	78 ft.		O.W.	1/25/58	64.7'	2/3/58	65.3'			SAND, CLAY, silty SAND ledge	1/24/58	
B-105	64 ft.	2.5" casing gravelly sand backfill	O.W.					2.5		silty, gravelly SAND, silty CLAY, SILT, refusal	1/23/58	
B-106	68 ft.									SAND, GRAVEL, TILL, refusal	1/31/58	
B-107	64 ft.		O.W.	1/31/58	22.6'	2/3/58	29.3'			silty SAND, SAND, CLAY, refusal	1/30/58	
B-108	69 ft.	#40 slot screen from 42.5' to 68.0'		1/30/58	3.0'	2/3/58	22.0'			SAND, SILT, GRAVEL	2/1/58	
B-109	24 ft.	#30 slot screen from 18' to 23'	O.W.	1/31/58	3.1	2/3/58	3.1	70		sandy CLAY, SAND	1/31/58	
B-110	37 ft.									gravelly SAND, SAND, SILT, Bedrock	2/1/58	
B-113	58 ft.									SAND, refusal		
O.W.-3	58 ft.		O.W.							SAND, SILT, CLAY		
O.W.-24	26 ft.		O.W.							SAND, CLAY		
O.W.-30	22 ft.		O.W.							CLAY		

Table 3-7
(Cont.)

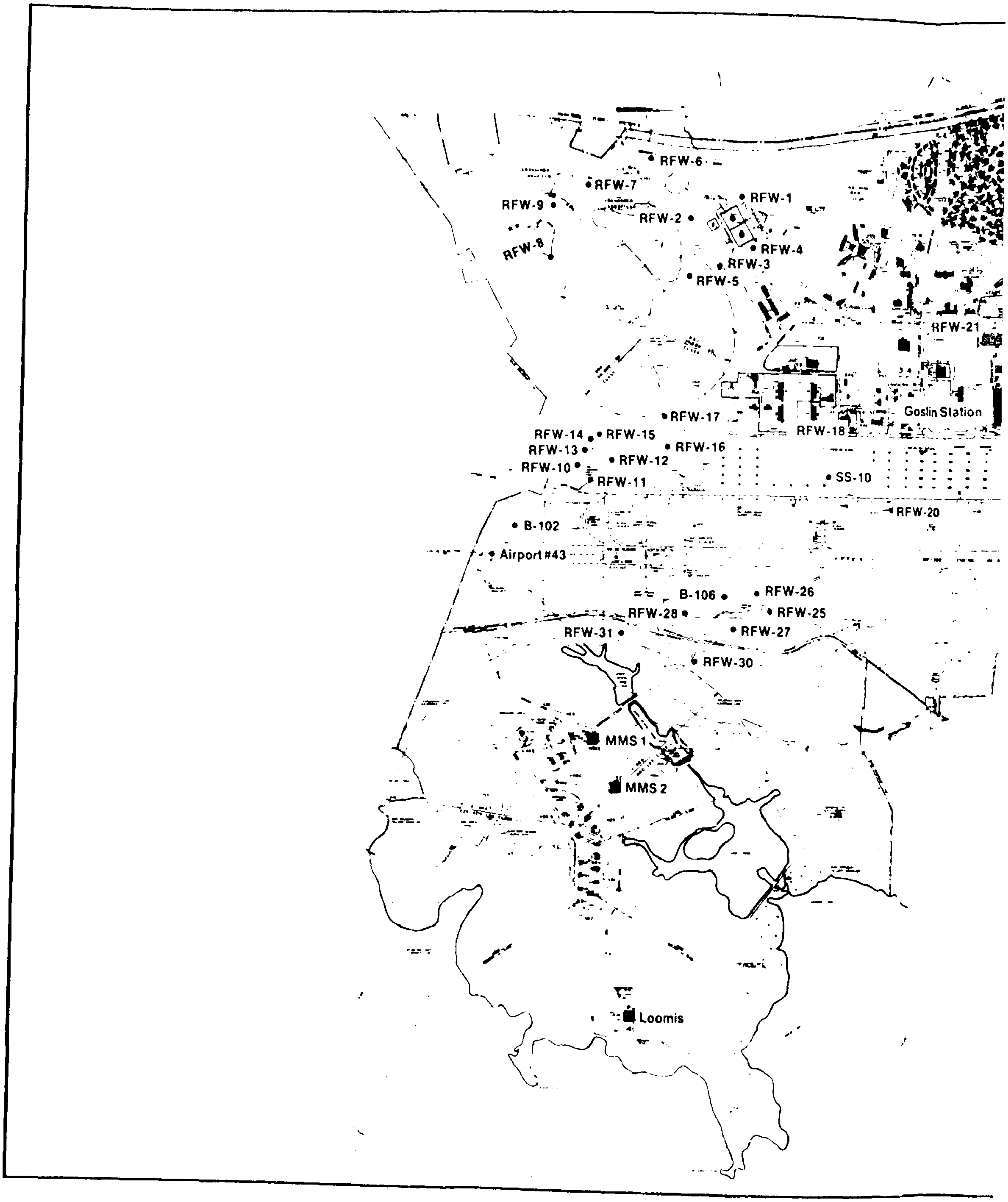
Well Identification	Depth of Boring	Well Construction	Use	DAR	SWL	DAR	SWL	Yield (gpm)	Type	Native Material	Date Completed	Remarks
S.S.-10	19 ft.									SAND; presently covered		
Airport #43	72 ft.									SAND, CLAY, GRAVEL		
Goslin Sta.	50-55 ft.	2.5" diameter	P.S.	11/ /53	10-12'			382	Dn	SAND, GRAVEL	1941	Battery of 52,2 1/2" wells on 2 pumping systems
Haven Sta.	60 ft.	8" diameter	P.S.	11/ /53	9.2'			455	Dr.	SAND, GRAVEL	1900	Battery of 3 wells on a pumping system.
No. 3	55 ft.	20" diameter	P.S	11/ /53	10.0'			208	Dr.	SAND, GRAVEL	1941	
Sherbourne Sta.	47-53 ft.	2.5" diameter	P.S.	11/ /53	4-4.5'			364	Dn	SAND, GRAVEL	1850	Battery of 50,2 1/2 inch wells
1	20 ft.	36" diameter		11/31/53	16.45'				Dg	SAND, GRAVEL	1900	
3	11.2 ft.	60" diameter		1/41/54	3.09'				Dg	SAND	1910	
7	119.5 ft.	6" diameter		1/26/56	25.62				Dr	Bedrock	1946	
8	414 ft.	8" diameter	P.S.	1/26/56	flowing			35	Dr	Bedrock	1955	
9	358	8" diameter	P.S.	9/ /55	9# 9.14			35	Dr	Bedrock	1958	
10	31-60 ft.	8" diameter	O.W.						Dr		1951	
11,12, & 26	10-68 ft.	2" diameter	O.W.						Dn		1951	
14-19	11-48 ft.	2" diameter	O.W.						Dn		1951	
13-16	15-70 ft.	8" diameter	O.W.						Dr		1951	
17-24	23-46 ft.	2" diameter	O.W.						Dn		1951	

Table 3-7
(Cont.)

Well Identification	Depth of Boring	Well Construction	Use	DAR	SWL	DAR	SWL	Yield) (gpm)	Type	Native Material	Date Completed	Remarks
25	70 ft.	12" diameter	P.S.					700	Dr	SAND, GRAVEL	1955	
Frank Jones		8 foot diameter	I						Dg			Battery of 8, foot wells
AB1 *		3 foot diameter	D						Dg			Filled in, no available data.
AB2 *			D						Dg			Filled in, no available data.

KEY

* Abandoned domestic wells; no available data
Dr Drilled well
Dn Driven well
Dg Dug well
OW Observation
PS Public supply
D Domestic
I Industrial
DAR Date recorded
SWL Static water level


RFW-6
RFW-7
RFW-1
RFW-9
RFW-2
RFW-8
RFW-4
RFW-3
RFW-5
RFW-21
Goslin Station
RFW-17
RFW-18
RFW-14
RFW-15
RFW-13
RFW-16
RFW-12
RFW-10
RFW-11
SS-10
RFW-20
B-102
Airport #43
B-106
RFW-26
RFW-28
RFW-25
RFW-31
RFW-27
RFW-30
MMS 1
MMS 2
Loomis

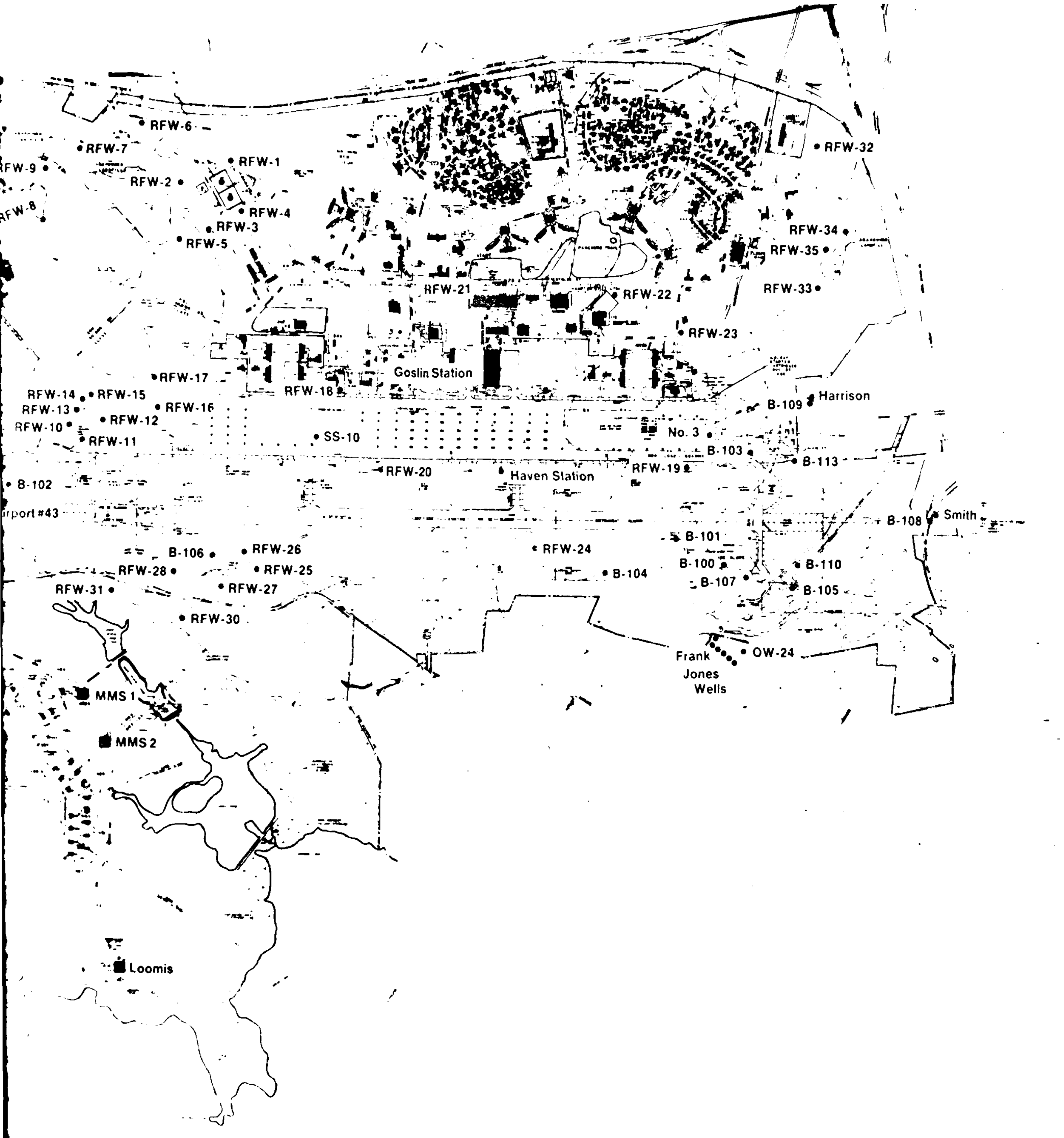

RFW-6
RFW-7
RFW-9
RFW-1
RFW-2
RFW-8
RFW-4
RFW-3
RFW-5
RFW-32
RFW-34
RFW-35
RFW-33
RFW-21
RFW-22
RFW-23
RFW-17
Goslin Station
RFW-14
RFW-15
RFW-18
RFW-13
RFW-16
RFW-10
RFW-12
RFW-11
SS-10
B-109
Harrison
No. 3
B-103
B-113
RFW-20
Haven Station
RFW-19
B-102
irport #43
B-108
Smith
B-101
B-106
RFW-26
RFW-24
RFW-28
RFW-25
B-100
B-110
B-104
B-107
RFW-31
RFW-27
B-105
RFW-30
Frank
Jones
Wells
OW-24
MMS 1
MMS 2
Loomis

FIGURE 3-1

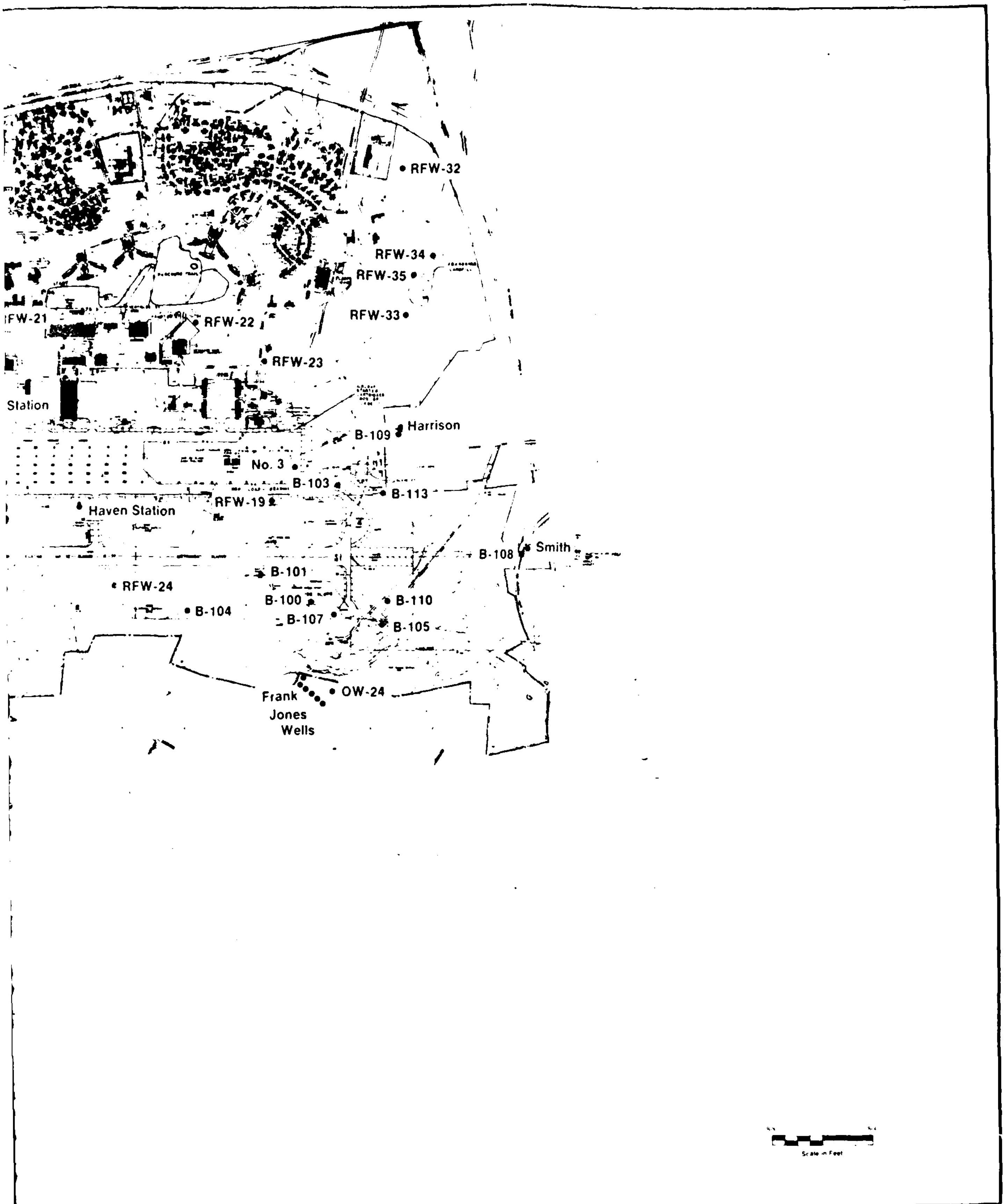


FIGURE 3-18 BASE WELL INVENTORY MAP

Hampshire Water Resource Research Center, and the United States Geological Survey Office in Concord, New Hampshire.

3.4 LITERATURE SEARCH

A complete review of existing literature pertaining to the hydrogeology of the Pease AFB area was conducted prior to and concurrent with the field investigation. Sources of the literature include: the Base files, the U.S. Geologic Survey, the U.S. Soil Conservation Service, the New Hampshire Department of Resources and Economic Development, the University of New Hampshire, the Phase I IRP Report, and WESTON's in-house files and library.

3.5 REVIEW OF AERIAL PHOTOGRAPHS

Prior to and concurrent with the field investigation, WESTON reviewed all available aerial photographs at the Base Civil Engineering Office and at the Rockingham County Soil Survey Office in Exeter, New Hampshire. The aerial photographs, both historical (pre-1956) and the most recent were used to help delineate the aeral extent of the sites/zones.

SECTION 4

RESULTS AND CONCLUSIONS

4.1 SITE INTERPRETIVE GEOLOGY AND HYDROGEOLOGY

4.1.1 Geologic Conditions

A review of available geologic data collected during the Phase I records search and subsequent Phase II field investigation indicates that the Pease AFB area has undergone a complex series of geologic events, as described in Section 2. The base is underlain by metasedimentary bedrock, glacial tills, marine clays, kame plain sands and gravel, marsh deposits and recent fill of varying thickness and areal extent.

The location of all new monitor wells installed in the Phase II Stage 1 investigation are shown on Figure 3-18. Bedrock was confirmed in 31 of the 35 monitoring wells by either drilling with a tri-cone rollerbit or an NX core barrel. Depths to bedrock varied from the ground surface at numerous outcrops in the north, northwest, and southeast portions of the base, to greater than seventy feet in RFW-18, located adjacent to the control tower in the central portion of the base. Samples from the bedrock cores consisted of slates and schists typical of the Kittery and Eliot Formations, as described by Novotny (1963).

Till was found directly overlying bedrock in 21 of the 35 monitoring wells and was encountered discontinuously throughout the base. The till is comprised of admixtures of clay, silt, fine sand, and gravel, and is dense to very dense, frequently requiring 40-100 blows to advance a split-spoon sampler six inches.

Blue/gray marine clay was found in wells located in the northeast, southeast, and western portions of the base. The marine clay stratum overlies glacial till. The marine stratum ranged between a soft plastic clay to clayey silt and frequently contained silt or fine sand stringers.

Sand and gravel covers most of the central portion of the base having been deposited as an ice-contact formation, referred to in this report as a kame plain. Exposed sections of the kame plain in gravel pits and split spoon samples show stratification within the formation. The particle

87 8 28 0 4 1

size ranged from fine sands to coarse gravel. In the northern portion of the base, sands and gravels were found in direct contact with fractured bedrock; elsewhere, they were generally underlain by marine clay and/or gravelly till above bedrock. In many areas the natural stratigraphy has been altered by cut and fill operations during construction of the roads, runways, and base facilities.

Figure 4-1 is a geologic cross-section running roughly north to south from RFW-32 at LF-6 to RFW-29 at LF-1. Figure 4-2 is a cross-section from east to west from RFW-6 at the BFSA to RFW-29 at LF-1. Locations of those cross-sections are shown in Figure 4-3.

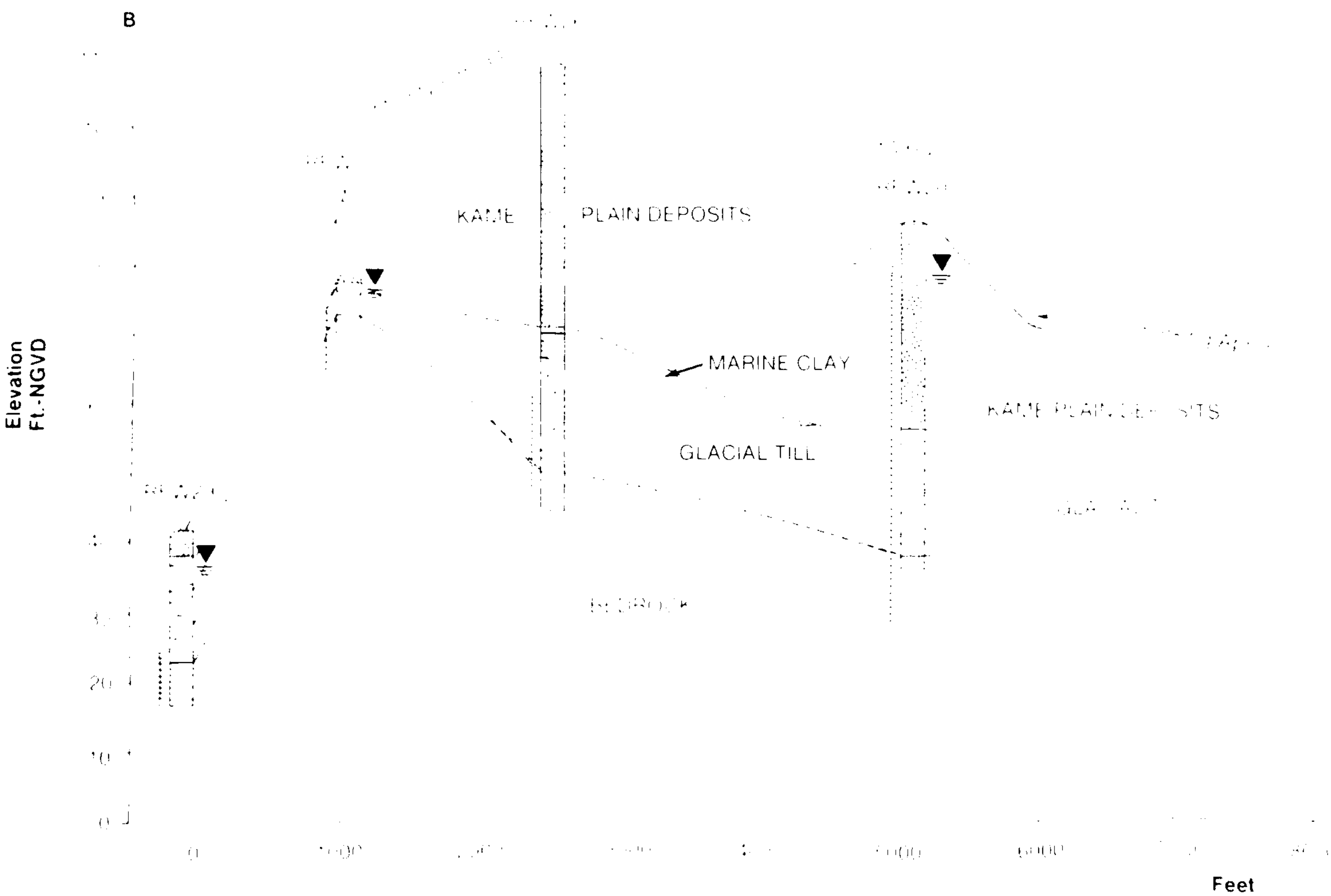
Figure 4-4 depicts the approximate bedrock surface contours based on existing well logs and data collected during the monitoring well installation program. The elevation of the paleosurface varies greatly across the base, ranging from greater than 100 feet above NGVD near the FDTA-2 to greater than 15 feet below NGVD near RFW-24. The bedrock was generally weathered at the interface with the overburden and was moderately to highly fractured in the core samples retrieved from various borings throughout the base.

4.1.2 Groundwater Conditions

4.1.2.1 Groundwater Occurrence and Flow Direction

Groundwater was found in both overburden deposits and in the underlying bedrock, in 33 of the 35 monitoring wells at Pease AFB. Two wells, RFW-15 (Figure 3-4) and RFW-23 (Figure 3-8), are constructed in an area of shallow kame plain deposits, and saturated conditions were found only in bedrock. Fluctuations in groundwater table measurements taken on the first and second sampling round showed that wells in the extreme downgradient locations in the south and west portions of the base experienced increases in water table elevations, while those in the upgradient, recharge areas showed decreases.

The regional groundwater flow, based upon the groundwater contour map in Figure 4-5, is essentially radial, from a groundwater high near the northern end of the main runway, and mimics the bedrock topography. Groundwater flow beneath approximately two-thirds of the base is towards the south-southeast. Figure 4-5 is a computer generated map of groundwater contours based on water level measurements


B
KAME
PLAIN DEPOSITS
MARINE CLAY
GLACIAL TILL
KAME PLAIN DEPOSITS
Elevation
Ft.-NGVD
20
0
6000
Feet

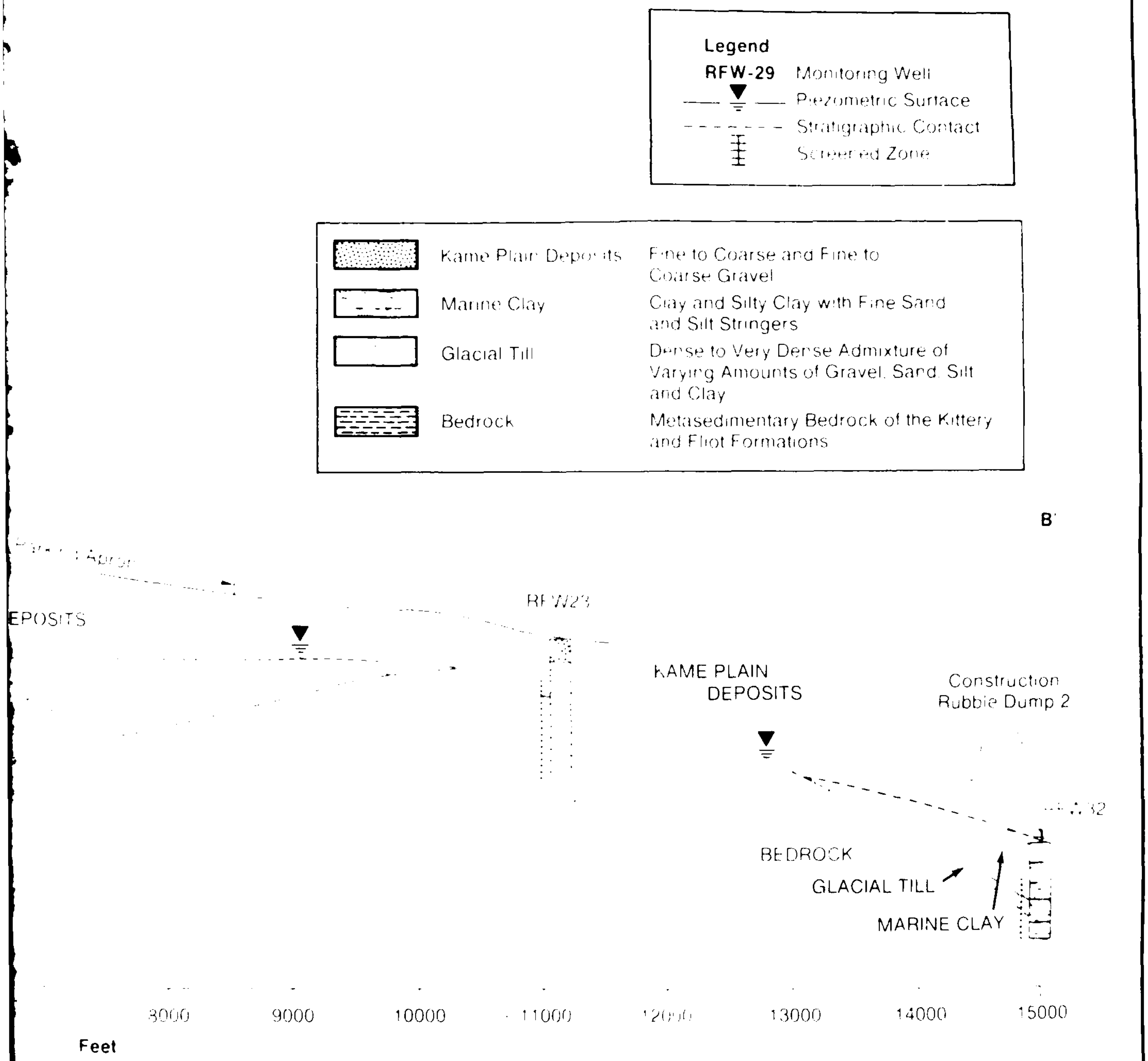
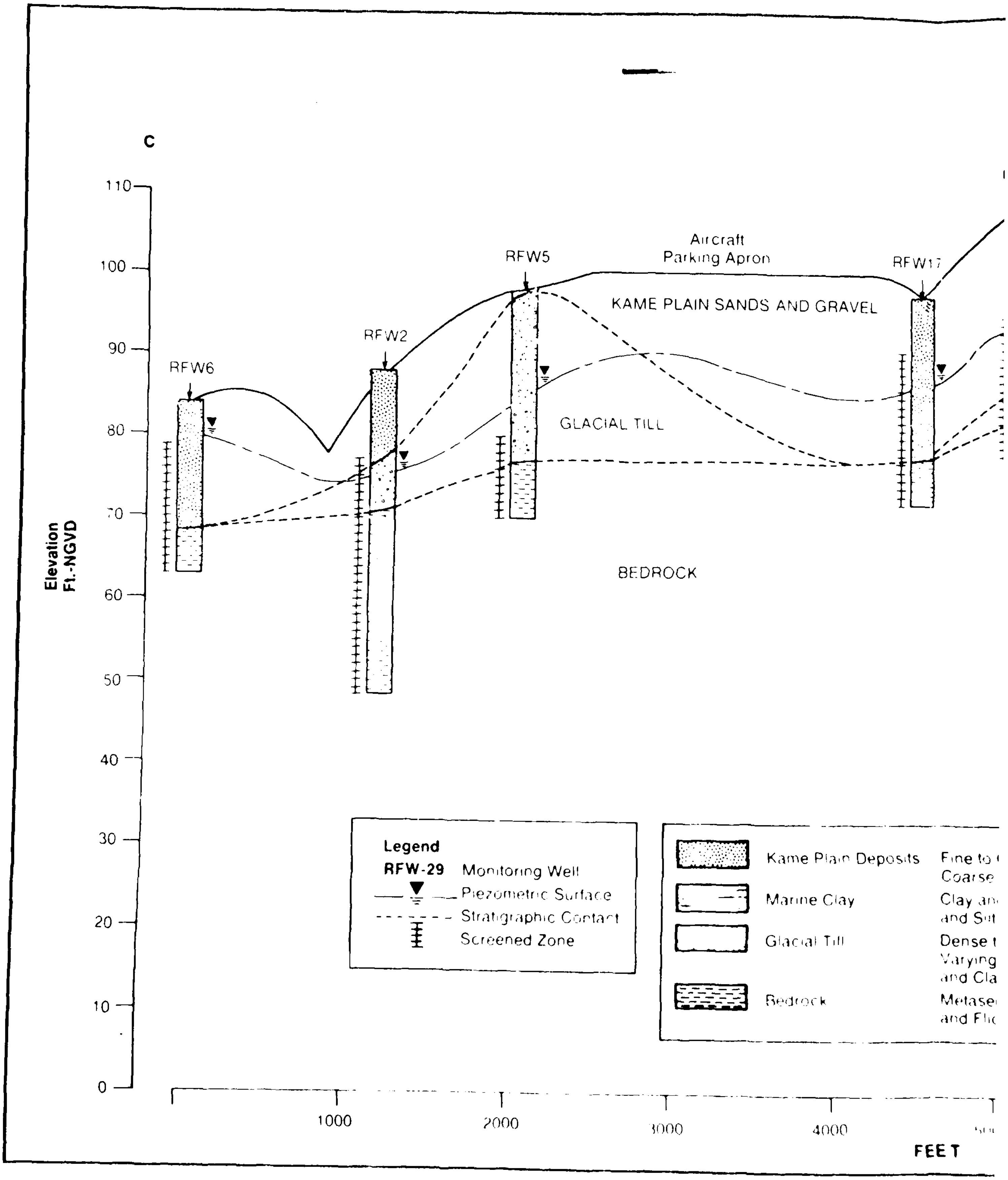


FIGURE 4-1 CROSS-SECTION B-B' - PEASE AFB


C
Elevation Ft.-NGVD
110
100
90
80
70
60
50
40
30
20
10
0
RFW6
RFW2
RFW5
Aircraft Parking Apron
RFW17
KAME PLAIN SANDS AND GRAVEL
GLACIAL TILL
BEDROCK
Legend
RFW-29 Monitoring Well
Piezometric Surface
Stratigraphic Contact
Screened Zone
Kame Plain Deposits
Marine Clay
Glacial Till
Bedrock
1000
2000
3000
4000
FEET

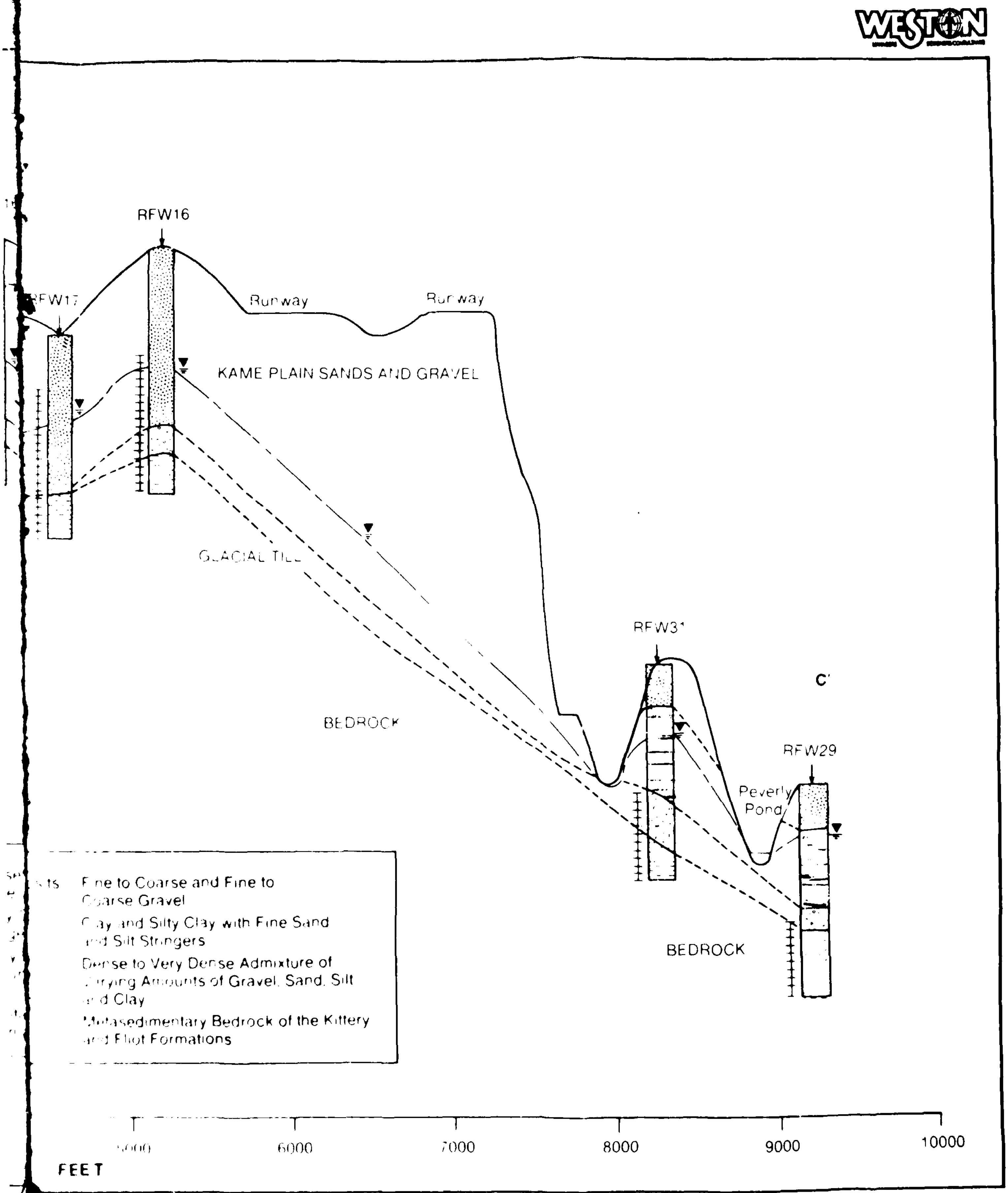


FIGURE 4-2 CROSS-SECTION C-C' - PEASE AFB

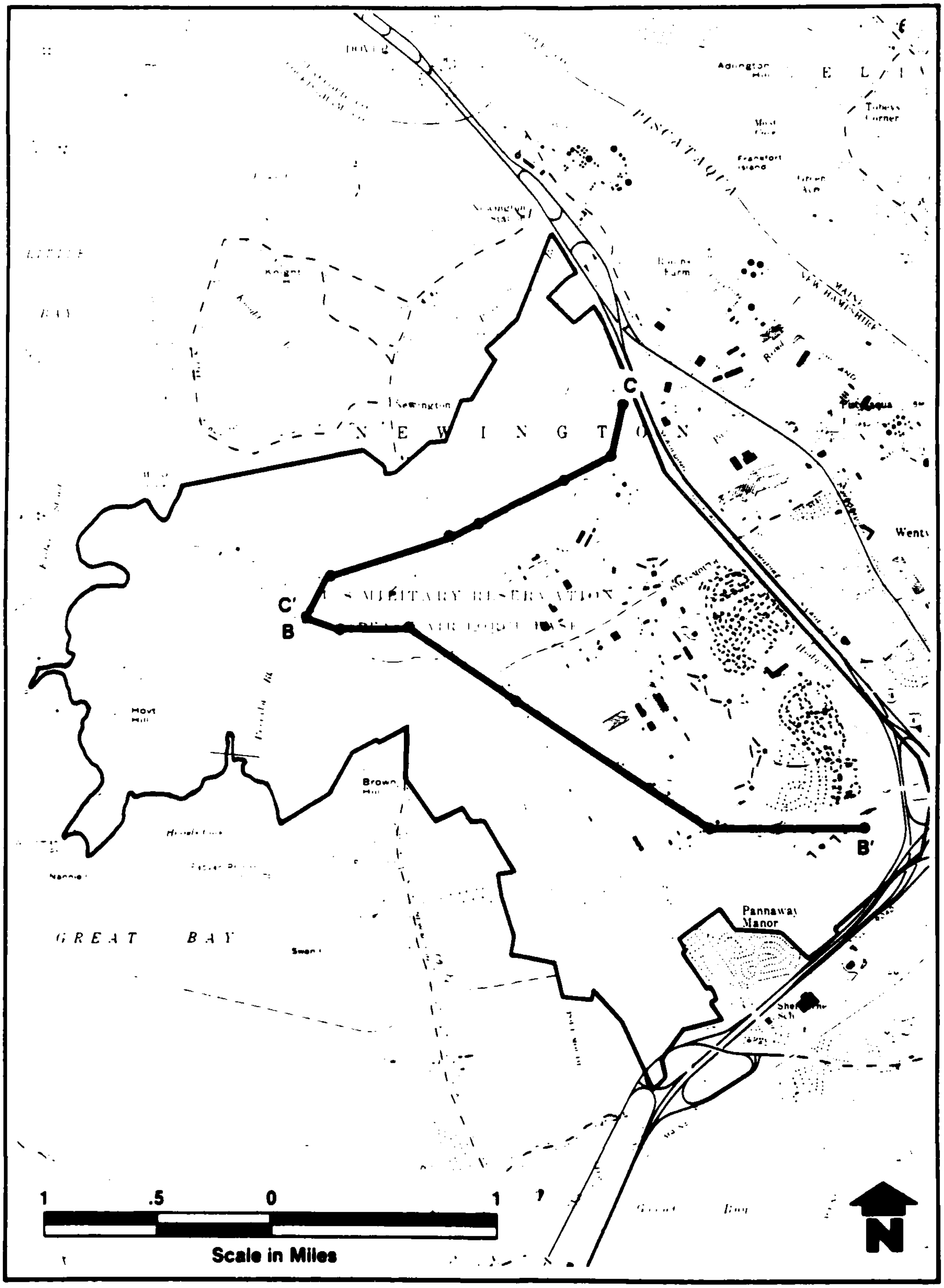


FIGURE 4-3 LOCATION OF CROSS SECTIONS B-B' AND C-C' - PEASE AFB

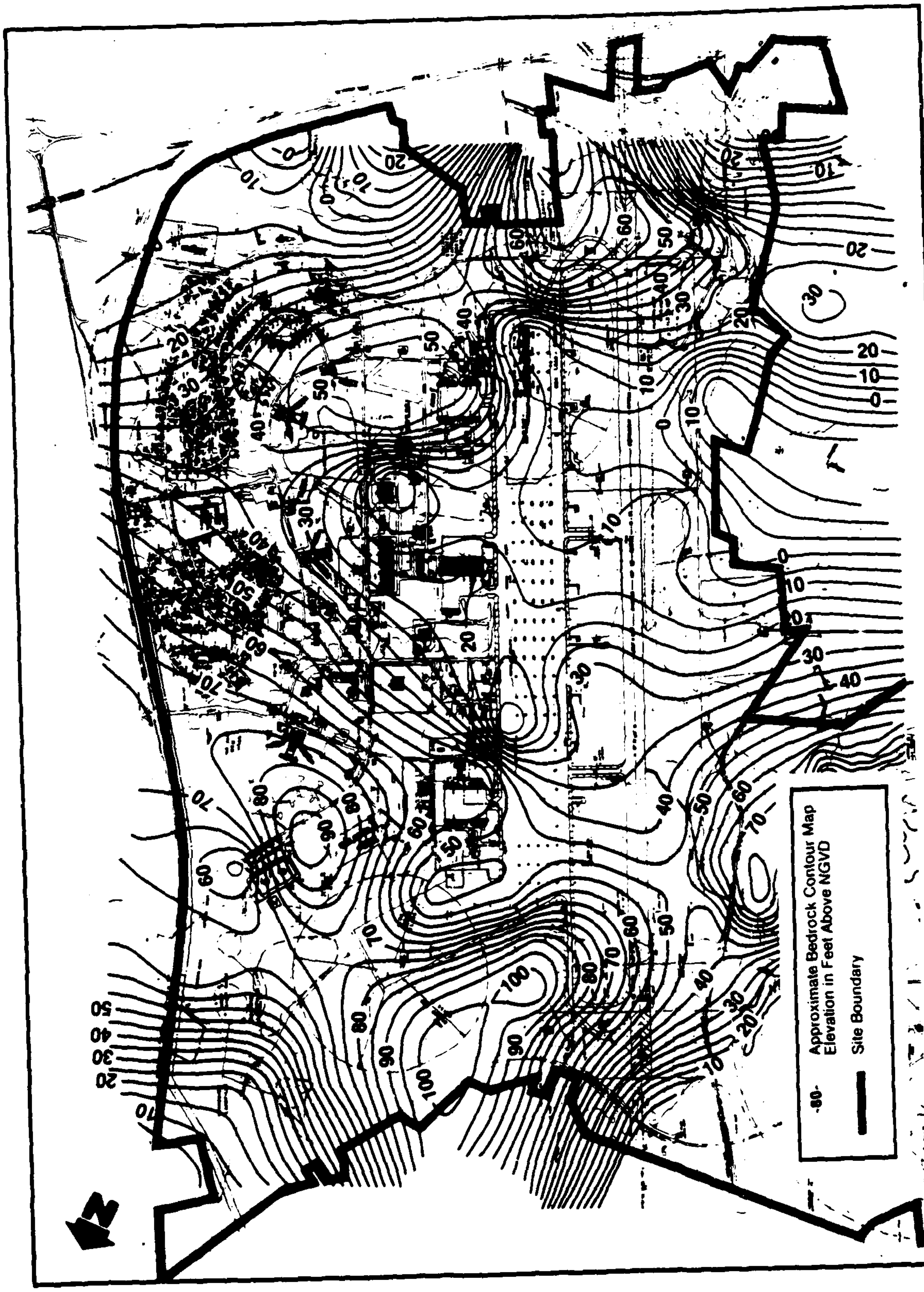
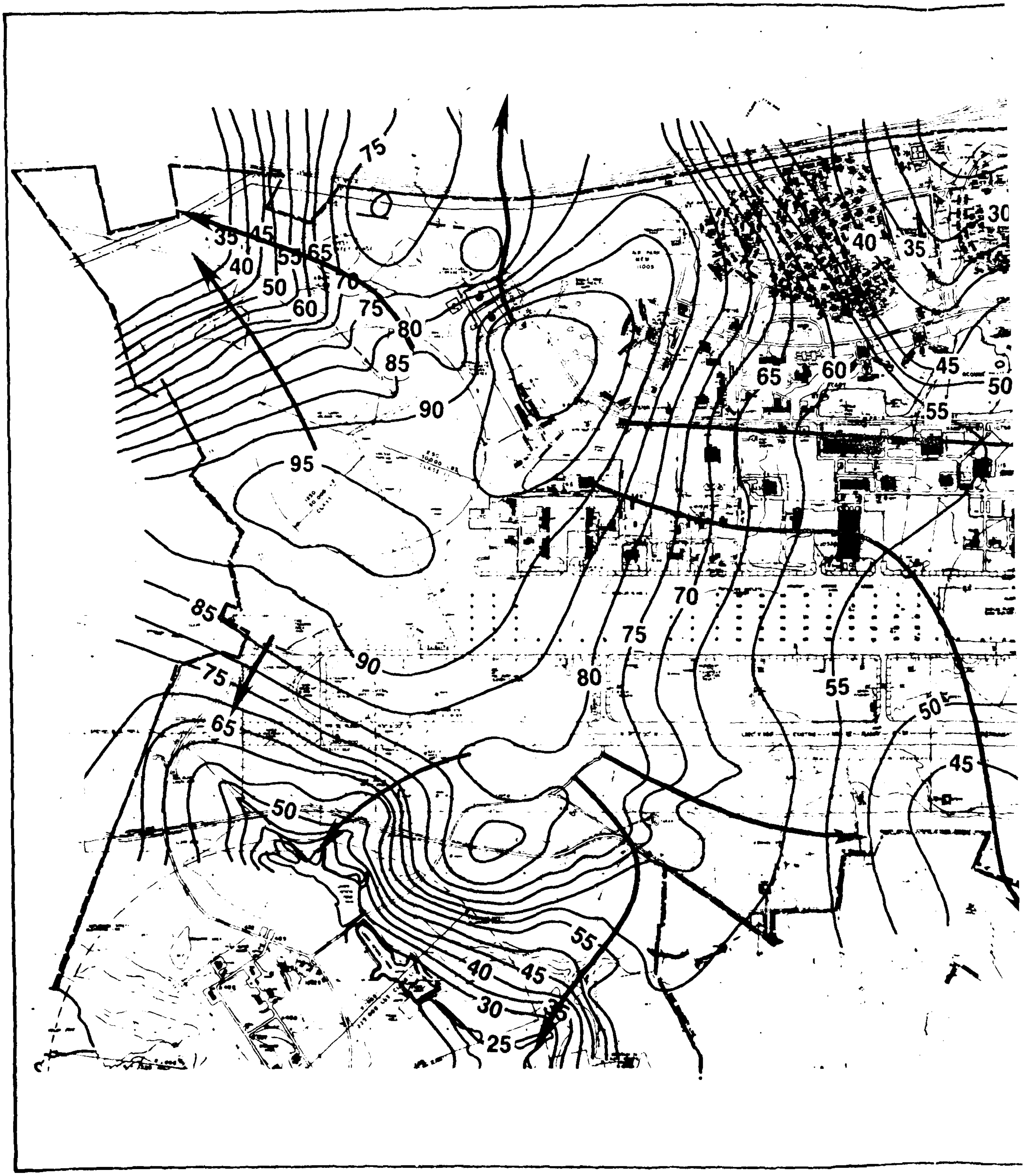


FIGURE 4-4 BEDROCK SURFACE CONTOUR MAP - PEASE AFB


75
35
45
55
65
40
50
60
70
75
80
85
90
95
85
90
75
65
50
80
75
70
65
60
40
35
30
45
50
55
55
50
45
55
40
45
30
35
25

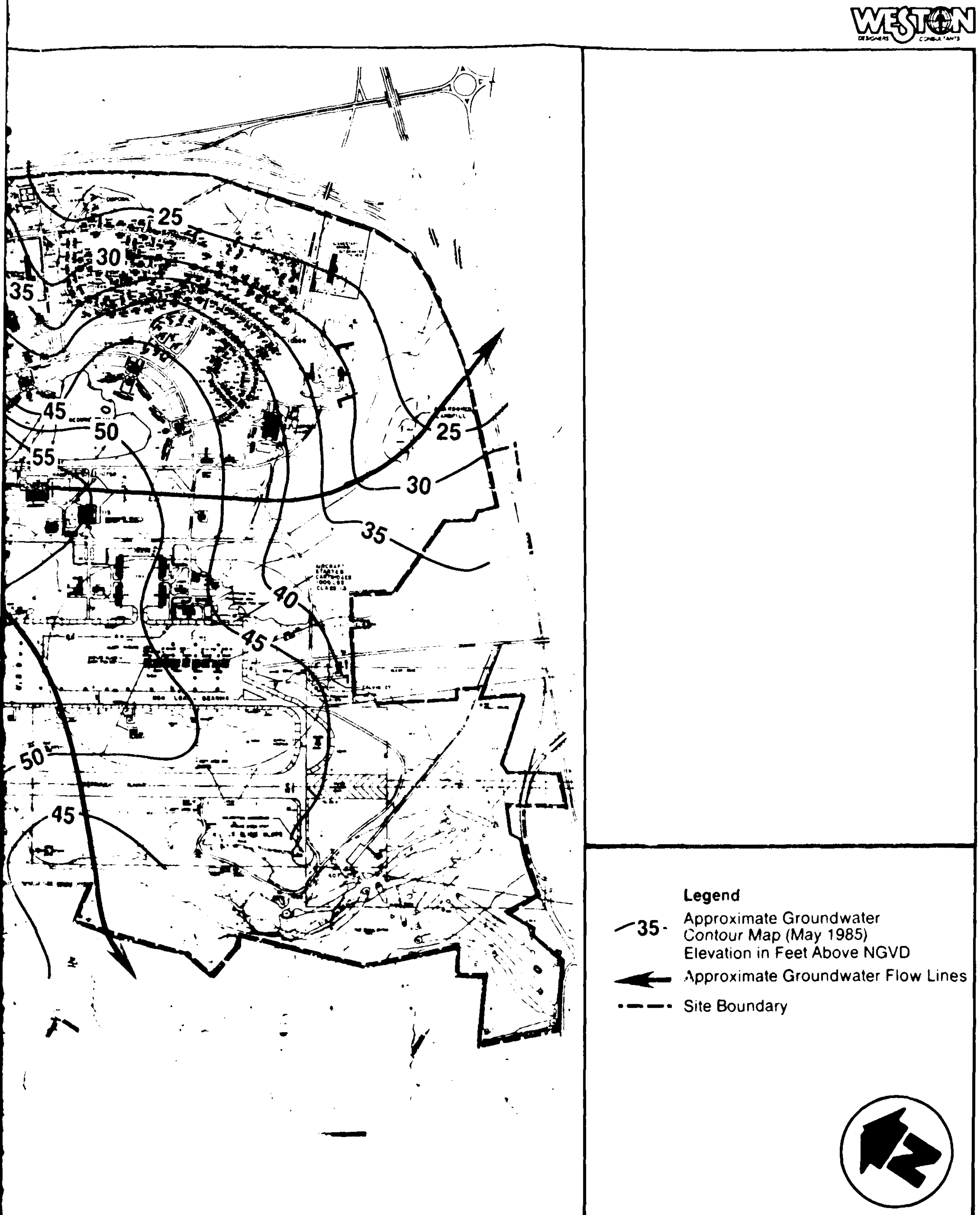


FIGURE 4-5 MAY 1985 APPROXIMATE GROUNDWATER CONTOUR MAP - PEASE AFB

taken during the period of 29 April to 7 May 1985. Groundwater flow lines, drawn perpendicular to the water table contours, show generalized, regional flow directions and illustrate the radial flow pattern. It can be assumed that most or all of the regional flow ultimately discharges to Great and Little Bays and the Piscataqua River.

Localized flow regimes probably vary from the regional flow, discharging to the various wetlands, streams, and drainage ditches found throughout the base. The presence of marine clay and/or glacial till strata beneath kame deposits and directly above bedrock in many areas of the base probably restrict vertical movement of groundwater and any associated contaminants which may be present. As a result, there is inferred to be greater flow in the upper, more permeable zones.

Perched water table conditions were found during the hydrogeologic investigation at LF-6, where marine clay underlies the site. Elsewhere, the low permeability of the tills and marine clays produce some localized artesian (confined or semi-confined) conditions. The water level in RFW-32 measured during the first round of groundwater sampling was approximately 0.4 feet above ground surface, indicating a confined condition and a probable upward vertical hydraulic gradient. Such a condition could inhibit the downward vertical migration of contamination into the bedrock flow zone. Semi-confined and artesian conditions probably exist elsewhere on the base, but could not be determined due to the scope of this investigation and the resulting lack of data on vertical head differences.

As described in Subsection 4.1.2.2, groundwater flow in bedrock is restricted to faults, fractures, and joints within the rock matrix. The direction and volume of flow is governed by the orientation, width, and frequency and interconnection of the fractures as well as by the distribution of hydraulic head in the bedrock aquifer.

4.1.2.2 Aquifer Permeability

The permeability of an aquifer is characteristic of the porous medium that makes up the aquifer, relating to its ability to transmit a fluid. In groundwater studies, it is usually expressed as hydraulic conductivity, which quantifies the ability of the medium to transmit a specific fluid, water. The hydraulic conductivity, commonly expressed in

feet per day (ft/day), is the volume of water that will pass through a unit cross-sectional area of the aquifer (perpendicular to the flow path) under a unit hydraulic gradient. In unconsolidated material, hydraulic conductivity depends on grain-size, degree of sorting, and grain arrangement, all of which affect the effective porosity in the sediment through which water can pass. In bedrock, the matrix itself typically has a very low permeability, and groundwater flows preferentially in the secondary porosity provided by fractures. Therefore, hydraulic conductivity in bedrock tends to be more variable from point to point, depending on the degree of fracturing and the nature of interconnection between fractures.

Data resulting from the <u>in situ</u> hydraulic conductivity tests were input into a computer program approximating the solution given by Bouwer and Rice (1976). Other input data included well construction, or "shape" factors. The results, in the form of an estimate of hydraulic conductivity for each well tested, are listed in Table 4-1.

The method is intended to give an order of magnitude estimate of hydraulic conductivity in the immediate vicinity of the point tested, and is not a definitive value for the aquifer as a whole. It depends on the following assumptions, adapted from Bouwer and Rice (1976):

- Introduction or removal of the slug is instantaneous, and drawdown of the water table around the well is negligible.
- Flow above the water table can be ignored.
- Head losses as water enters the well are negligible.
- The well is screened in a single medium that is homogeneous and isotropic.

Several factors caused test conditions at Pease AFB to diverge from these ideal conditions, including the following: 1) many of the wells tested were screened in more than one type of sediment, or across both sediment and bedrock; 2) many of the wells were screened above the water table, for sampling purposes, resulting in initially high intake rates when a slug was added to the well; and 3) slug introduction or removal could not be instantaneous. Despite these

WESTON

Table 4-1

SUMMARY OF IN-SITU PERMEABILITY TEST RESULTS

Well No.	Hydraulic Conductivity cm/sec	Hydraulic Conductivity ft/day
RFW-1	3.0×10^{-5}	0.08
RFW-2	1.5×10^{-5}	0.04
RFW-3	5.5×10^{-4}	1.6
RFW-4	5.5×10^{-5}	0.2
RFW-5	---	---
RFW-6 (1)	2.6×10^{-4}	0.7
RFW-6	1.3×10^{-4}	0.4
RFW-7	3.5×10^{-5}	0.1
RFW-8	1.3×10^{-5}	0.04
RFW-9	1.7×10^{-4}	0.5
RFW-10	1.7×10^{-4}	0.5
RFW-11	---	---
RFW-12	5.2×10^{-6}	0.01
RFW-13	1.2×10^{-4}	0.3
RFW-14	8.1×10^{-5}	0.2
RFW-15	2.6×10^{-4}	0.7
RFW-16	1.8×10^{-3}	3.6
RFW-17	7.3×10^{-4}	3.1
RFW-18	---	---
RFW-19	---	---
RFW-20	6.0×10^{-5}	0.2
RFW-21	3.4×10^{-4}	1.0
RFW-21 (1)	5.8×10^{-5}	0.2
RFW-22	5.5×10^{-5}	0.2
RFW-23 (1)	2.6×10^{-4}	0.7
RFW-23	2.1×10^{-4}	0.6
RFW-24	4.9×10^{-4}	1.0
RFW-25	1.5×10^{-4}	0.4

Table 4-1 (Cont.)

SUMMARY OF IN SITU PERMEABILITY TEST RESULTS

RFW-26	1.3×10^{-5}	0.4
RFW-27	4.4×10^{-5}	0.1
RFW-28(1)	7.0×10^{-4}	2.0
RFW-28	7.0×10^{-4}	2.0
RFW-29	3.3×10^{-4}	0.9
RFW-30	2.3×10^{-4}	0.7
RFW-31	6.8×10^{-4}	2.0
RFW-32	1.3×10^{-4}	0.4
RFW-33	3.1×10^{-6}	0.009
RFW-34	2.3×10^{-5}	0.07
RFW-35	3.8×10^{-5}	0.1

--- Well not tested

(1) Well tested twice, once in drawdown phase and once in recovery phase.

limitations, slug tests do provide rough, first-cut estimates of hydraulic conductivity. Where several data points are available, they are very useful for determining the range in hydraulic conductivity to be expected in the medium tested. However, many authors have noted that slug tests often yield lower estimates of hydraulic conductivity than aquifer tests in pumping wells, sometimes by as much as two orders of magnitude (Faust and Mercer, 1985). For this reason, it is generally best to use conservative estimates from the high end of the range for predictive purposes.

It is concluded that the hydraulic conductivity values derived from in situ testing are probably underestimates for the most permeable materials screened (generally the sands and gravels of the kame deposits) and overestimates for the least permeable (generally the tills or marine clays).

Table 4-2 summarizes typical ranges of hydraulic conductivity for three broad classes of aquifer materials encountered at Pease AFB. The ranges obtained from the slug or recovery tests (first column) have been compared to ranges presented in background literature for similar materials (second column) to derive a reasonable range that can be used for predictive purposes in the discussion of groundwater flow rates that follows (third column). Based on this information, it can be seen that the sand and gravels form the most permeable aquifer materials, and that bedrock in the uppermost weathered zones has a moderate permeability. The marine clays and glacial tills exhibit the lowest permeabilities at the site, and may act as confining layers where they overlie more permeable sand or bedrock, thus resulting in restricted flow between high and moderate water bearing zones.

4.1.2.3 Groundwater Velocity and Contaminant Migration

For the purpose of discussing potential rates of contaminant transport, linear velocity is used. This "seepage" velocity is a function of the aquifer permeability, the hydraulic gradient, and the effective porosity of the formation, and is expressed by the following equation:

$$Vs = Ki/Ne \qquad \text{eqn. 4.1}$$

Where:

Vs = Groundwater (linear seepage) velocity (L/T)

WESTON

TABLE 4-2

TYPICAL RANGES IN HYDRAULIC CONDUCTIVITIES
OF SUBSURFACE MATERIALS ENCOUNTERED
AT PEASE AFB

Lithologic Material	Range in Hydraulic Conductivity (Ft/Day)		
	From In-Situ Permeability Tests	From Background Literature (1)	Representative Range for Predictive Purposes
Bedrock	0.04-2	0.001-10	0.04-2
Kame Deposits (sand & gravel)	0.2-5	10-5,000	1-100
Marine Clay and Glacial Till	0.009-0.5	10^{-5}-0.1	0.001-0.1

(1) Sources: Davis and DeWiest, 1966
Freeze and Cherry, 1979
Todd, 1980

K = Average hydraulic conductivity (L/T)
i = Hydraulic gradient (dimensionless)
Ne = Effective porosity (dimensionless)

Computation of travel times for contaminants within the groundwater are speculative due to variations in constituent concentrations, density, solubility, and their reactivity or interaction with aquifer material. A conservative approximation can be made by assuming that contaminants are nonreactive constituents traveling at the same average velocity as the groundwater. As contaminant plumes migrate away from a site their concentrations decrease due to dispersion and dilution from infiltrating precipitation and groundwater in storage.

The volume of groundwater flowing through a site is also of concern when considering potential adverse impacts to the environment. Groundwater discharge is given by equation 4.2:

$$Q = KiA \qquad \text{eqn. 4.2}$$

Where:

Q = Groundwater flow or discharge (L^3/T)
K = Average hydraulic conductivity (L/T)
i = Hydraulic gradient (dimensionless)
A = Cross-sectional area of aquifer (L^2)

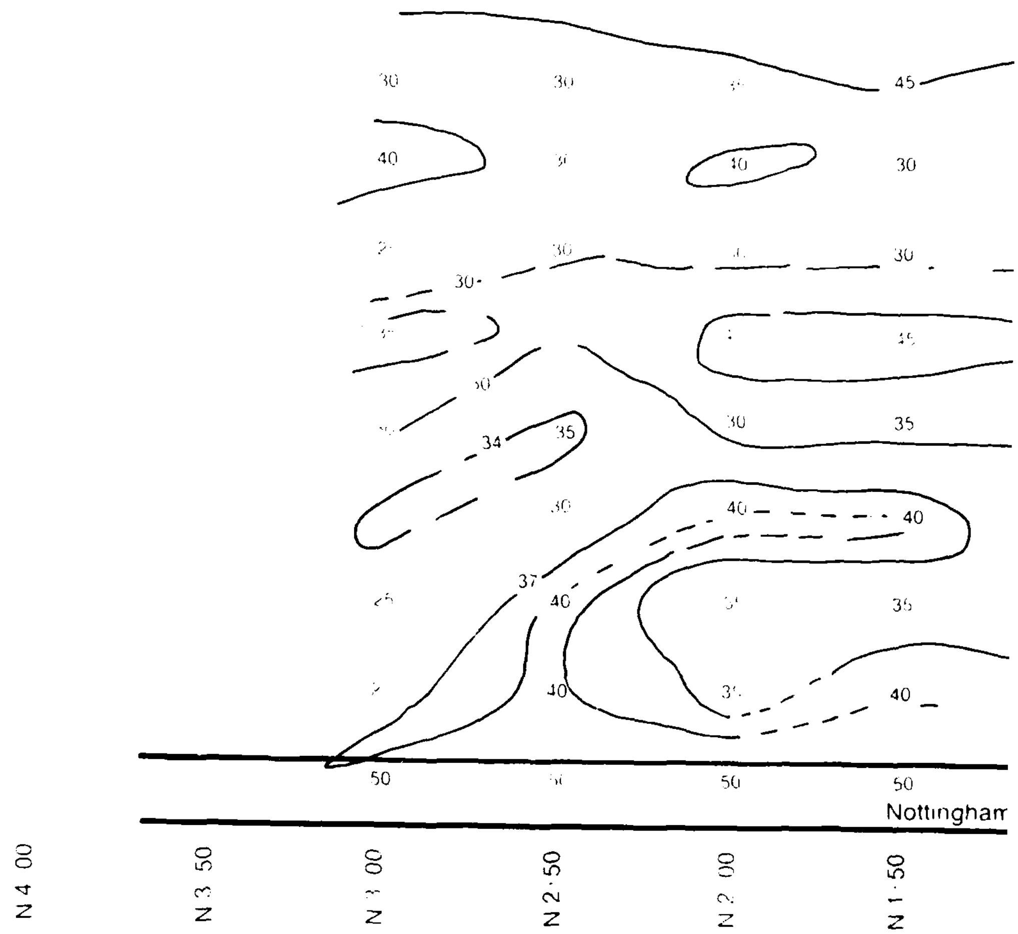
These basic flow equations have been used to estimate flow rates and flow volumes for groundwater beneath selected sites at Pease AFB.

4.2 RESULTS OF THE GEOPHYSICAL INVESTIGATION - LFTS

The results of the ground penetating radar, (GPR) and magnetometer survey at the leaded fuel tank disposal area (LFTS) are presented in the following paragraphs. As discussed in Subsection 3.2.3, the data gathered by the two geophysical methods are complementary when applied to the interpretation of site conditions.

4.2.1 Results of the Magnetometer Survey

The results of the magnetic survey were used to develop a contour plot of magnetic anomalies for two areas as shown on Figure 4-6 and 4-7. WESTON used a Radian CPS-1 computer



30
30
45
40
40
30
30
30
30-
35
34
35
30
30
35
40
40
37
40
35
40
40
50
50
50
Nottingham
N 4 00
N 3 50
N 2 50
N 2 00
N 1 50

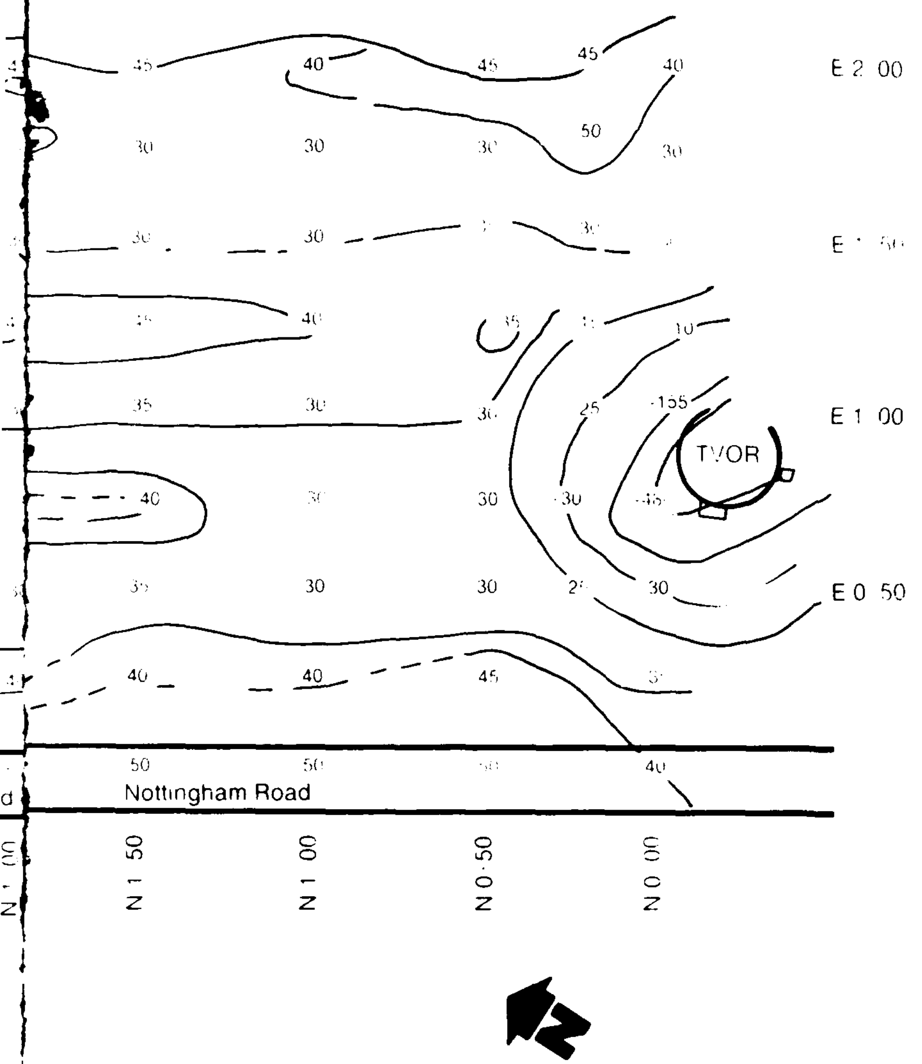
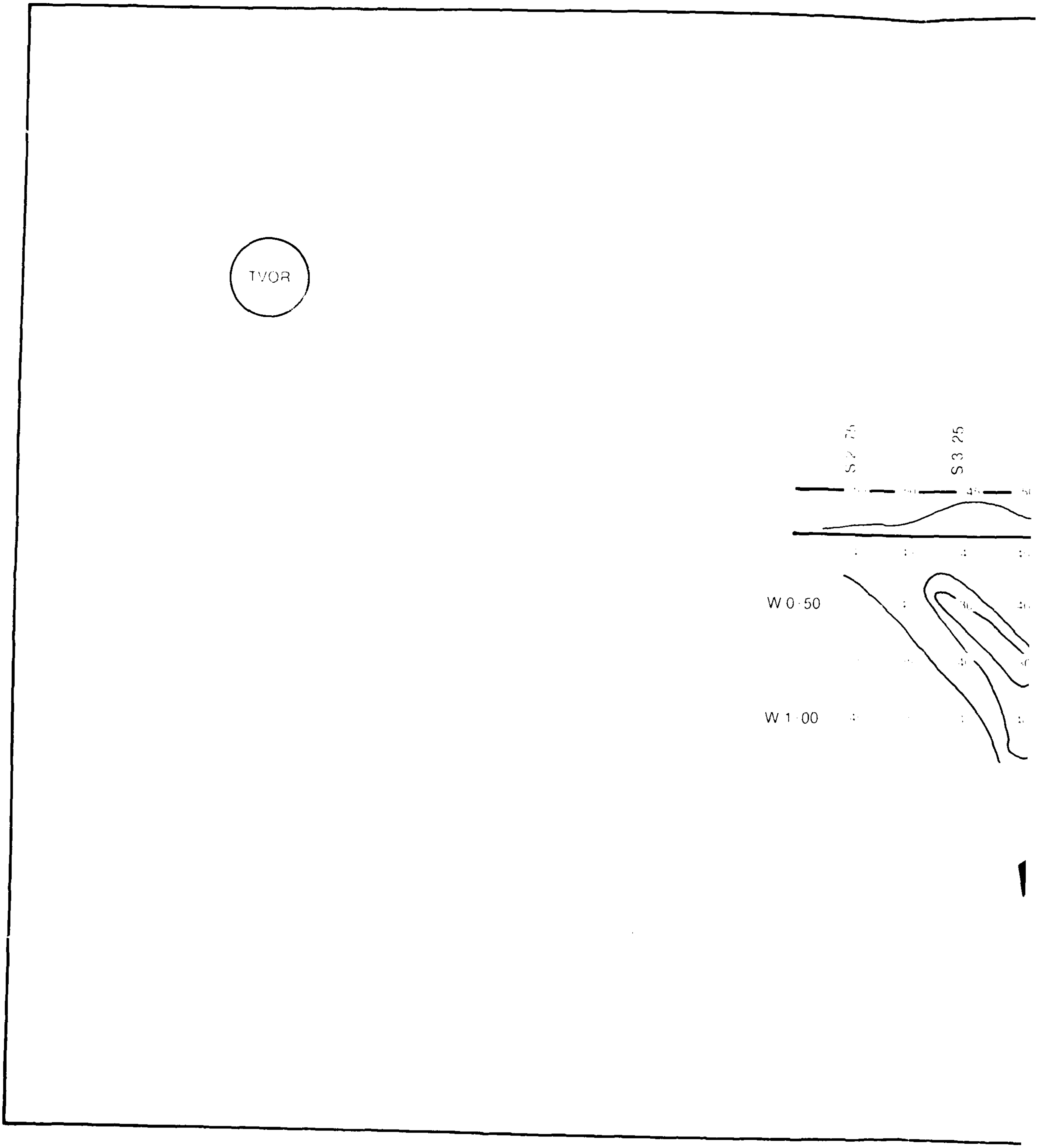
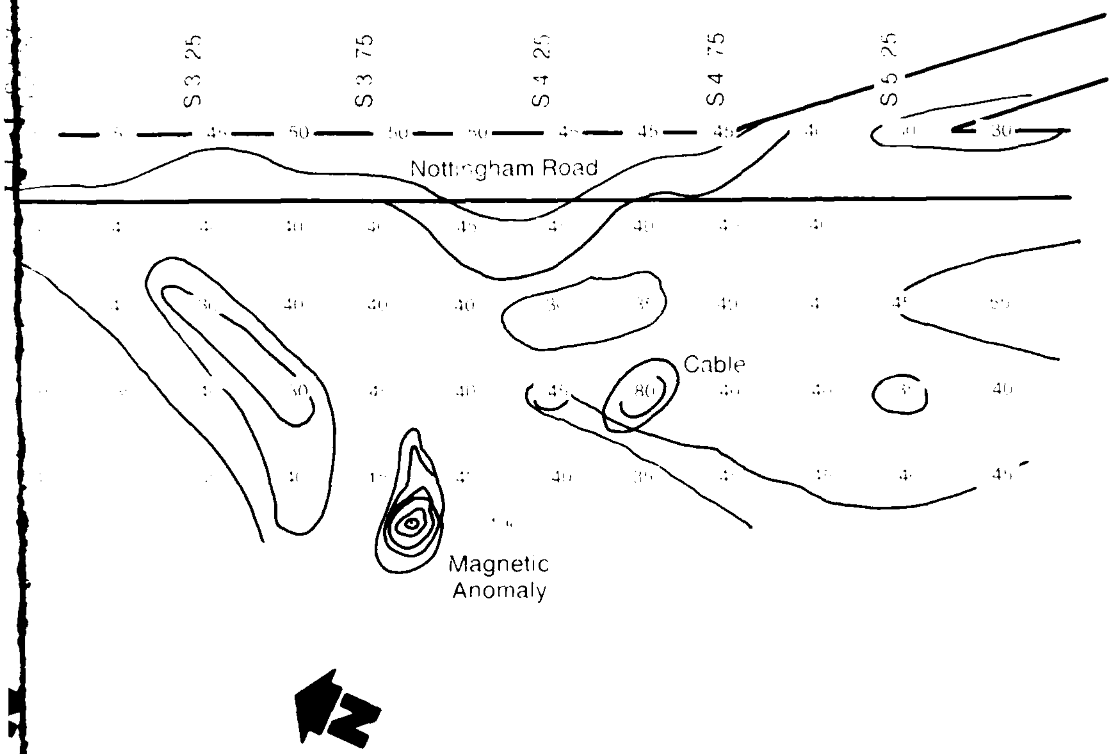


FIGURE 4-6 LFTS NORTH SUBSITE - CONTOUR PLOT OF VERTICAL MAGNETIC FIELD


TVOR
S2 75
S3 25
W 0·50
W 1·00



WESTON

FIGURE 4-7 LFTS SOUTH SUBSITE - CONTOUR PLOT OF VERTICAL MAGNETIC FIELD

2

graphic contour plotting system to construct the contour solutions for the node locations surveyed. After the reduced magnetic readings were computer-plotted and contoured on base maps of the two LFTS subsites a qualitative examination of the contour map was performed and major features were noted.

The most prominent magnetic feature in the north LFTS sub site (Figure 4-6) is the magnetic depression at the center of the south edge of the site. This anomaly is associated with the TVOR facility adjacent to the site. The remainder of the site readings were all evenly distributed within a range of normal instrument fluctuation (±15 gammas) and, therefore, indicate no significant subsurface anomalies at the north site.

The magnetic anomaly contours at the south LFTS site show two anomalous high points. One point, as indicated on Figure 4-7, can be attributed to a known buried cable. The other magnetic high area of 190 gammas, located at (grid node) W1+15 by S3+90 indicates a target. This target was also located by GPR methods as discussed in the following subsection.

4.2.2 GPR Survey

After calibration, a vertical scale was set to each cross-section as explained in Subsection 3.2.3.3. Each of these figures shows a subsurface structure which was typical of all the traverses. Between depths of one and two feet there were two horizons of high reflection. These horizons are mostly uniform and continuous across the site and probably represent undisturbed soil horizons or layered fill material. Below the horizontal features, the GPR profiles showed prominent layered features dipping to the north and west. This pattern probably represents dipping stratified ice contact or Kame plain deposits. The dip along the east-west and north-south traverses is about 5 degrees. This feature appears in both grid areas and extends to the depth of penetration of the instrument, approximately 15 feet.

The GPR survey of the north LFTS subsite indicated no point anomalies or targets. Remote sensing results were equivocal, and confirmation by direct sampling was required to determine the nature of layered subsurface materials. Test pit excavations (Figure 3-12) of the upper two to three feet

revealed no sludge layers. Therefore, the targets probably represent the soil horizons.

The GPR survey of the south side of the LFTS south of Nottingham Road (Figure 3-12) identified three targets. Of the three targets, one, located S3+90 by W1+15, correlates with the magnetic high area discussed in the previous section. The depth of this target is estimated to be around 5 feet. The other two targets (S4+50 by W0+90, and S4+45 by W1+100) are not associated with magnetic anomalies. The approximate depth of the latter targets are 7 and 10 feet respectively. Excavation of test pits in the first target area uncovered a "nest" of three buried, sludge-filled drums. Excavations in the other areas revealed no evidence of drums or buried sludges.

4.2.3 Summary

No significant anomalies were identified at the north LFTS subsite by either magnetic or GPR methods. The possible presence of sludge deposits could not be distinguished from natural soil horizons at shallow depths. Direct sampling was required to confirm the absence of buried sludges.

At the south LFTS subsite (Figure 4-7), three unknown targets were identified by the GPR traverses at depths of between 5 and 10 feet. Of the three, one target is associated with a high magnetic anomaly, and appeared a likely location of buried metal objects. This was confirmed by the excavation of test pits at the anomaly. All other test pits at suspect anomalies did not encounter buried drums or sludges. These conclusions are limited to only those areas investigated by geophysical methods.

4.3 ANALYTICAL RESULTS

4.3.1 General

A principal objective of the Phase II Stage 1 Problem Confirmation Study was to determine whether past hazardous waste operations or disposal practices at the site had resulted in significant environmental impact or confirmable degradation. The analytical results of the Phase II study are based on field testing, sampling of selected soils, stream sediment, surface water, production wells, newly installed monitoring wells and two abandoned waste solvent tanks. Wells RFW-1 through RFW-35, production wells PW-1

through PW-6, surface water sampling locations SW-1 through SW-22, and SW-24 through SW-31 were sampled on two occasions.

The analytical results from each of the two rounds of sampling were compared and evaluated to determine if contaminant concentrations were consistent in the two rounds. Large variations in water quality data in groundwater samples over a short period of time may indicate the presence of laboratory artifacts or other extraneous data rather than a source of contamination at the site. Surface water quality is more susceptible to temporal changes than groundwater. Second sample confirmation of the presence of analytes may indicate the presence of a source of contamination.

The presence of detectable concentrations of analytes in trip blanks and/or field blanks was considered in the interpretation of the analytical results for samples collected on the same day, or analyzed in the same batch as the blank. For example, nickel was detected in eleven groundwater samples at concentrations ranging from 0.20 to 0.32 mg/l. A field blank which was analyzed in the same batch of samples contained 0.19 mg/l. Therefore, the presence of nickel was not concluded to be attributed to on-site conditions. The analytical results for duplicate samples were compared to each other to evaluate the consistency of the findings.

A number of sites were resampled due to missed holding times or deviation from specified analytical protocols. The results of the re-sampling are included below.

The analytical protocols for each site have been presented in Table 3-1. The analytical methods and required detection limits are listed in Appendix H. The analytical protocols selected at each site were specified by the USAFOEHL following a review of the Phase II Presurvey Report. The analytical results for all valid samples are presented in the site-specific summary tables below. Laboratory analyses reports of all samples collected during the Phase II Study are included in Appendix I. Appendix J contains a complete listing of Federal and State drinking water and human health standards, criteria, and guidelines applicable in New Hampshire. These criteria were used as the basis for evaluating the significance of the analytical findings.

At some sites, a "screening" protocol consisting of total organic halogens (TOX), total organic carbon (TOC) and oil and grease (O&G) analyses was used to make an initial assessment of gross contamination in soils or water at a given site. All three analyses measure groups of organic compounds rather than individual components. Of these, TOX has the lowest detection limit (5 ug/l) and is, therefore, most likely to correlate with the low concentrations of halogenated volatile organic compounds (VOC) previously detected at Pease AFB. The detection limits for both TOC (1.0 mg/l) and O&G (0.1 mg/l) are in general too high for these parameters to be correlated to specific organic compounds such as trichloroethylene (TCE) previously found in groundwater at Pease AFB. According to Harper (1984), the TOX method is considered "a very good approximation of the true total of all chlorine, bromine, or iodine from organic compounds. As such, it provides the potential to 'screen' and to determine in one step whether significant quantities of halogenated organics are present. Since more than half of the EPA's priority pollutants are halogenated, a straightforward screening measurement is thus available."

TOC and oil and grease (O&G) analyses are the other non-specific screening methods used to quantify total organic contaminants. By comparing analytical results for the three parameters on a sample-by-sample and site-by-site basis, basewide trends were determined. Table 4-3 lists ranges of concentrations (background, low, and elevated) for each analyte which was used in interpreting the significance of concentrations of the non-specific screening protocols. Concentrations of the analytes in the "background" range are considered to be prevalent and indicative of naturally occurring conditions over the areas monitored at Pease AFB. The low concentration range indicates a possible impact on environmental quality. The elevated concentration range samples showed a significant increase in analyte concentrations above background and low concentrations.

The screening protocol data was evaluated with the specific analyte data and the *in situ* analytical data to categorize the Phase II sites.

At sites where historical records indicated that specific wastes, such as leaded fuel sludges, JP-4, or trichloroethylene (TCE) were disposed, specific analytical protocols were specified to confirm and quantify the impact of these to the environment. The specific protocols included

WESTON

Table 4-3

SCREENING PROTOCOL RESULTS AND INTERPRETIVE RANGES

	RANGE	TOX	TOC	O&G
Groundwater	(1)	nd-822 ug/l	nd-339 mg/l	nd-134 mg/l
	Background	< 20 ug/l	< 20 mg/l	< 1.0 mg/l
	Low	20-50 ug/l	20-50 mg/l	1.0-2.0 mg/l
	Elevated	> 50 ug/l	> 50 mg/l	> 2.0 mg/l
Surface Water	(1)	nd-2630 ug/l	nd-25.2 mg/l	nd-6.24 mg/l
	Background	< 60 ug/l	< 20 mg/l	< 1.0 mg/l
	Low	60-100 ug/l	20-50 mg/l	1.0-2.0 mg/l
	Elevated	> 100 ug/l	> 50 mg/l	> 2.0 mg/l
Soils & Sediment	(1)	nd-67.5 mg/kg	n/a	nd-73600 mg/kg
	Background	< 0.1 mg/kg	n/a	< 100 mg/kg
	Low	0.1-0.5 mg/kg	n/a	100-1000 mg/kg
	Elevated	> 0.5 mg/kg	n/a	> 1000 mg/kg

n/a- not applicable(soils & sediment not analyzed for TOC)

(1)- range of concentrations detected during Phase II Stage 1 IRP Study

analysis for cyanide, phenols, the U.S. EPA Priority Pollutant Organic Compounds including volatile organics, pesticides and herbicides, and selected metals, where appropriate. Table 4-4 lists typical ranges for naturally-occurring heavy metals in soils from North America. These ranges can be generally compared to reported values in the summary tables below in evaluating the presence of contaminants at non-natural levels. However, it should be noted that natural soil quality varies widely since soils are, in part, composed of minerals.

4.3.2 Federal and State Water Quality Standards

A complete listing of applicable Federal and New Hampshire drinking water and human health standards is provided in Appendix J. This subsection reviews the evolution and meaning of those standards. The U.S. EPA originally promulgated a set of interim primary drinking water standards based on human health criteria in 1975, to which was added a set of recommended secondary drinking water standards based on taste, odor, and aesthetic considerations. In 1980, the U.S. EPA adopted the term "maximum contaminant level" (MCL) for all current drinking water standards.

On 28 November 1980, the U.S. EPA issued criteria for 64 toxic pollutant categories which could be found in water (Appendix J). The criteria established recommended maximum concentrations for acute and chronic exposure to these pollutants for both human and aquatic life. The derivation of these exposure values was based on cancer risk, toxic properties, and organoleptic properties.

The limits set for cancer risk were not based on a "safe" level for carcinogens in water. The criteria stated that, for maximum protection of human health, the concentration should be zero. However, where this cannot be achieved, a range of concentrations corresponding to incremental cancer risks of from 1 in 10 million to 1 in 100,000 (10^{-7} to 10^{-5}) was presented.

In addition to the cancer risk assessment criteria, the EPA Office of Drinking Water provides, on request, advice on health effects concerning unregulated contaminants found in drinking water supplies. This information suggests the level of a contaminant in drinking water at which adverse health effects would not be anticipated with a margin of safety; it is called SNARL (suggested no adverse response

Table 4-4

TYPICAL RANGES OF METALS CONCENTRATIONS IN SOILS

Metal	Chemical Notation	Typical Concentrations (ppm)
Arsenic	As	1-50
Barium	Ba	100-5000
Cadmium	Cd	0.01-7.0
Chromium	Cr	5-1000
Copper	Cu	2-100
Iron	Fe	14000-42000
Lead	Pb	2-200
Mercury	Hg	0.02-0.2
Nickel	Ni	5-500
Selenium	Se	0.1-2.0
Silver	Ag	0.1-1.0
Zinc	Zn	2- 30

From Pressant (1971) and Allaway (1968)

level). Normally, values are provided for 1-day, 10-day, and longer-term exposure periods where available data exist. A SNARL does not condone the presence of a contaminant in drinking water, but rather provides useful information to assist in the setting of control priorities in cases where the contaminant has been found. SNARLs have been adopted by the New Hampshire Water Supply and Pollution Control Commission as legally enforceable standards. SNARLs may or may not lead ultimately to the issuance of a national standard or maximum contamination level (MCL). The latter must take into account the occurrence and relative source contribution factors in addition to health effects. It is quite conceivable that the concentrations set for SNARL purposes might differ from an eventual MCL. The SNARLs may also change as additional information becomes available.

On 12 June 1984, the U.S. EPA published a set of proposed rules under the Safe Drinking Water Act that would establish recommended maximum contaminant levels (RMCL) for the following volatile synthetic organic chemicals (VOC) in drinking water: trichloroethylene, carbon tetrachloride, 1,1,1-trichloroethane, vinyl chloride, 1,2-dichloroethane, benzene, 1,1,-dichloroethylene, and p-dichlorobenzene. The RMCL for these eight compounds were adopted in November 1985.

RMCL are non-enforceable health goals that were set at levels that would result in no known or anticipated adverse health effects with an adequate margin of safety. This action was the initial stage of rulemaking for the establishment of federal primary drinking water regulations for the eight VOC. Following this action, maximum contaminant levels (MCL) and monitoring/reporting requirements were proposed when the RMCL were promulgated. The MCL will be enforceable standards. They will be set as close to the RMCL as is feasible, and are based on health, treatment technologies, costs, and other factors. The proposed MCL concentrations range from a low of 1 ug/l for vinyl chloride to 750 ug/l for p-dichlorobenzene. All MCL are within 5 ug/l of the RMCL.

The State of New Hampshire has adopted current Federal MCL for 20 chemicals and radionuclides. In addition, in December 1983, New Hampshire incorporated the U.S. EPA SNARLS into their drinking water regulations, stating that public water supplies shall not contain concentrations of substances for which SNARLs have been established, in excess

of the listed values. Also regulated by this document are gasoline and "other hydrocarbons," (Appendix I).

4.3.3 Interpretation of Analytical Results - General

4.3.3.1 Interpretive Results - Screening Protocols

The use of TOX, TOC, and O&G results to evaluate the contamination profiles in a confirmation study have limitations. As discussed above these protocols measure groups of organic compounds rather than specific components. This fact can be especially important in areas such as the fire department training areas where solvents have reportedly been burned. The burning of these chlorinated hydrocarbon compounds can result in partial decomposition and the formation of polynuclear aromatic hydrocarbon compounds, or other hazardous materials that would not be identified by the screening protocols. The sites where this may have occurred at Pease AFB are the FDTA-1, FDTA-2, and Site 22.

As discussed in Section 4.3.1, TOX, TOC, and O&G analyses were used as a screening methodology to assess comparative levels of contamination and to determine if further, more specific analyses were warranted. By comparing analytical results for the three parameters on a sample by sample and site by site basis, base-wide water quality trends can be determined. Table 4-5 lists data from TOC, TOX, and O&G analyses for both rounds of surface water and groundwater samples.

An examination of Table 4-5 indicates that most of the groundwater sampling points exhibited concentrations of TOX at 20 ug/l or less on at least one occasion. For this reason, and in consideration of other laboratory and field results, TOX values of less than 20 ug/l have been interpreted to be attributable to background conditions (Table 4-3). In contrast to the background results, four monitoring wells exhibited TOX results at least one order of magnitude higher than the 20 ug/l concentration. These results were concluded to represent comparatively elevated concentrations of TOX. TOX results within a range of 20-50 ug/l were interpreted to be indicative of low concentrations where potential impacts from prior site use might be inferred.

Table 4-5

Summary of Screening Protocol Results - Groundwater

Site	RFW #	TOX ug/l	TOC mg/l	O&G mg/l
BFSA	1	20-17	3.7-.27	1.97-0.61
	2	36-36	3.1-4.1	0.26-0.52
	3	nd-nd	0.8-0.9	0.31-0.49
	4	6-5	1.6-2.1	0.38-0.34
LF-2	5	18-11	0.8-1.0	nd -0.68
Through	6	19-28	2.1-1.7	nd -3.2
LF-5	7	7-40	2.5-3.2	nd -nd
	8	83-7	3.0-2.4	0.76-0.36
	9	nd-11	0.6-0.8	0.15-0.14
FDTA 2	10	351-140	9.6-1.2	1.61-134
	11	8-27	1.2-39.4	0.57-2.09
	12	100-6	20.6-0.8	1.32-0.86
	13	10-8	3.2-3.3	0.53-2.13
	14	6-5	1.8-1.6	0.20-0.26
	15	10-12	0.4-1.3	0.18-0.31
FMS	16	5-12	3.1-0.9	0.25-0.49
FLS	17	-----	-------	0.33-0.59
IS/PA	18	11-10	1.8-0.6	0.84-0.50
	19	5-12	0.9-1.3	1.6-0.32
	20	11-27	1.7-1.7	1.7-0.50
	21	8-23	17.5-0.9	0.66-1.14
	22	6-8	6.0-0.8	0.20-0.35
	23	11-14	1.2-0.9	0.31-nd
	24	nd-12	3.2-nd	2.25-0.47
LFTS	25	-----	-------	0.59-3.29
	26	-----	-------	0.21-0.45
Site 22	27	-----	-------	2.09-2.14
FDTA 1	28	5-nd	1.2-0.8	0.51-1.40
LF-1	29	34-20	21.8-9.1	0.40-0.35
	30	nd-11	1.9-1.1	0.50-0.55
	31	43-17	15.3-12.5	0.13-1.02
CRD 2	32	40-57	12.3-5.2	0.30-0.45

AD-A184 842 INSTALLATION RESTORATION PROGRAM PHASE 2 CONFIRMATION/QUANTIFICATION STAG..(U) WESTON (ROY F) INC WEST CHESTER PA R L KRAYBILL ET AL. AUG 87 3/4

UNCLASSIFIED F33615-84-D-4400 F/G 24/4 NL

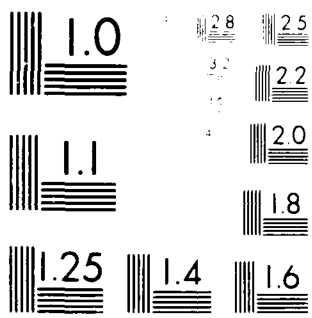

1.0
2.8
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

Table 4-5 (Cont.)

Summary of Screening Protocol Results - Surface Water

Site	SW #	TOX ug/l	TOC mg/l	O&G mg/l
McIntyre Brook	19	22-23	2.7-8.0	0.28-0.23
	20	19-24	2.7-8.4	0.31-0.73
Grafton Ditch	21	31-23	9.3-6.7	0.10-0.17
	22	34-20	3.4-6.7	0.26-2.5
LF-6	24	31-53	6.2-14.0	0.10-0.12
	25	17.3	1.7-8.6	1.09-nd
	26	13-36	7.8-9.7	1.42-0.15
	27	74-32	9.1-9.9	0.29-0.13
	28	74-35	15.4-8.6	0.74-0.75
CRD 2	29	62-35	14.9-13.0	0.97-0.19
Newfields Ditch	30	127-28	13.8 -8.5	0.30-1.79
	31	38-22	5.0 -6.4	0.11-0.13
QA/QC Samples	5 (b)	nd	nd	nd
	23 (b)	-----	nd	nd
	32 (d)	17	nd	nd
	33 (d)	9	-------	0.58
	34 (d)	23	nd	nd

-- = Analyte not reported in sampling protocol
nd = None detected
b = Field blank
d = Quality control duplicate. RFW-39 is a duplicate of RFW-24 in the first sampling round, and RFW-17 in the second sampling round. SW-32, SW-33 and SW-34 are duplicates of SW-13, SW-12 and SW-23, respectively.

In several instances, two rounds of results from the same groundwater sampling point, exhibited entirely different concentrations of TOX (Table 4-5). No consistent pattern could be established between concentrations in first and second round samples. In cases where disparities in results occurred between sampling rounds, conclusions regarding the results were based on subjective assessments of all of the screening results and any other available analyses.

Surface water analytical results for TOX are consistently higher throughout the base than the groundwater results. This observation cannot be explained, especially in view of the positive correlation between other screening analytes for surface and groundwaters (Table 4-3). Surface waters typically exhibited concentrations ranging up to 60 ug/l TOX with no other indications of contamination by TOC or O&G (Table 4-5). Therefore, these concentrations were interpreted to be representative of background conditions.

In situations where a screening parameter was elevated in one sampling round and at low or background levels in the other round, the interpretation of results considered all other laboratory or field findings. An example of this is seen on Table 4-5 for the CRD-1. The second round TOX result was almost two orders of magnitude higher than the first round result. No positive correlation could be found with the O&G results. Furthermore, no field information indicated anything unusual about the sample nor did downstream testing suggest adverse impacts. Consequently, the interpretation of this anomalously elevated TOX value was put in perspective with the other available documentation of overall site conditions.

The TOC concentrations in the majority of the surface water and groundwater samples (Table 4-5) were within the typical backgroundwater quality range cited in Table 4-3 (<20 mg/l). Of 31 groundwater sampling points, only six exhibited TOC concentrations above anticipated background levels on one or more occasions. Only two of 26 surface water stations exhibited TOC concentrations above background on one occasion. Elevated TOC results (>50 mg/l) were noted at only three lc --ions. These locations are associated with a landfill (LF-6) and the results generally correlate with elevated TOX and other evidence of contamination.

Table 4-3 shows that the interpretive ranges for background, low, and elevated concentrations of TOC in ground and surface waters are the same. This basis of interpretation is consistent with the observations of field and laboratory test results.

The Oil and Grease method, is useful as a general indicator of contamination arising from the disposal or spills of fuel, lubricating oils, or other petroleum hydrocarbon. For the purpose of interpretation, the upper limit of background concentrations of O&G in surface and groundwaters was 1 mg/l. Those results which exhibited concentrations above 2 mg/l were generally concluded to be elevated.

Table 4-5 indicates that most of the surface and groundwater samples collected in two rounds of sampling were representative of background concentrations. Background concentrations of oil and grease were often associated with low or background concentrations of TOX and TOC although significant exceptions to this were apparent. An example of this disparity is evident in the results from LF-6 (Table 4-5).

In certain instances, only one round of sample results from a location exhibited elevated O&G. Wells RFW-24 and RFW-25 (Table 4-5) illustrates this situation. Also, no overall trends in the concentrations could be concluded to have occurred between sampling rounds. As with the other screening parameters, the interpretation of elevated results were considered in context with all of the analytical findings and the field results. For example, no floating hydrocarbons were found in any of the monitoring wells. The O&G screening results are supported by this field observation.

Stream sediment and soil sample analyses for TOX and O&G are listed in Table 4-6. The significance of these findings

TABLE 4-6

SUMMARY OF SCREENING PROTOCOL RESULTS - SOIL AND SEDIMENTS

Site	Sample #	TOX mg/kg	O&G mg/kg
McIntyre Brook	SD-1	0.1	130
	SD-2	nd	180
Grafton Ditch	SD-3	0.1	84
	SD-4	nd	88
	SD-5	1.6	3220
Newfields Ditch	SD-6	0.8	2200
	SD-7	nd	930
FDTA-1	7-TP-1	10.0	24400
	7-TP-2	1.0	898
Site 22	22-TP-4	nd	2480
FDTA-2	8-TP-1	0.1	37
	8-TP-2	0.3	199
	8-TP-4	nd	2180
	8-TP-6	nd	368
	8-TP-8	nd	237
	8-TP-9	0.1	5790
LFTS	10-B-1	--	41
	10-B-2	--	50
	10-B-3	--	2220
	10-B-4	--	1980
	10-TP-5	--	2370
	10-TP-6	--	8720
FMS	11-TP-15	26.0	56700
	11-TP-15A	22.0	73600
	11-TP-16	nd	80
	11-TP-17	--	50
MSA	12-B-1	0.7	217
	12-B-2	0.1	149
	12-B-3	nd	37
FLS	14-B-1	--	171
	14-B-4	--	1170
	14-B-5	--	10

Site	Sample #	Bldg #	TOX mg/kg	O&G mg/kg
	15-B-1	119	67.5	1800
	15-B-2	119	nd	55
	15-B-3	113	nd	27
	15-B-4	113	0.1	947
	15-B-5	226	0.2	1290
	15-B-6	226	0.6	21
	15-B-7	226	0.3	116
IS/PA	15-B-8	244	0.3	nd
	15-B-9	244	0.5	24
	15-B-10	222	0.4	14
	15-B-11	222	0.5	691-53
	15-B-15	234	0.3	53-nd
	15-B-17	234	nd	nd
	15-B-18	120	1.4	1460
	15-B-19	113	0.2	601
	15-B-22	113	0.3	68
	15-B-24	229	0.3	194

nd = None Detected
-- = Parameter not specified

are, in general, less definitive than those for water samples, since soil materials are not homogeneous. Furthermore, contaminants are less often evenly distributed because soil types have different affinities for organic materials, and the analytical protocols (TOX in particular) are less precise in assessing the magnitude, and hence the significance of contamination in soil. Where observed, soil samples were collected from the strata that contained the highest suspected levels of contaminants based on visual inspection and in situ HNu readings. Therefore, the results should be considered to represent worst-case conditions at a site rather than overall soil quality.

The majority of the soil samples contained less than 0.5 mg/kg TOX and, for the purposes of this report, that value is assumed to be a low concentration in soil. Of the 39 soil and sediment samples analyzed for TOX, 18 were at background concentrations ranging from "none detected" to 0.1 mg/kg; 9 sample results ranged between 0.1 and 0.5 mg/kg and, for interpretative purposes, were concluded to represent a low concentration level. Twelve samples were concluded to exhibit elevated concentrations of TOX.

Oil and grease concentrations in the soil samples ranged from "none detected" to 73,600 mg/kg. Concentrations of O&G greater than 1,000 mg/kg were found in 16 of the 49 sampling locations. That value is one order of magnitude greater than the background level discussed in Section 4.3.1 and indicates definite contamination by oil and grease.

In all but one instance (15-B-6), analyses that exceeded 0.5 mg/kg TOX showed correspondingly elevated levels of O&G (Table 4-6). Soil samples 7-TP-1 and 7-TP-2, for example, were taken from shallow test pits at FDTA-1. The concentrations of TOX (10.0 and 1.0 mg/kg) and O&G (24,400 and 898 mg/kg) in both samples indicate elevated concentrations of these screening parameters.

The most elevated TOX result of 67.5 mg/kg was collected in the IS/PA. This result was more than one order of magnitude higher than 16 other soil samples collected from this zone. Of the 17 soil samples collected from suspect areas in the zone, 12 exhibited background or low concentrations. These screening results assisted in the overall assessment of this zone.

In summary, screening protocols consisting of TOX, TOC and O&G were specified in the statement of work (Appendix B) for surface water and groundwater. The screening protocols for soils were TOX and O&G. Based upon an assessment of concentration ranges (Table 4-3) and the results of the screening protocols (Tables 4-5 and 4-6), several sites exhibited elevated levels of these screening parameters at one or more locations in soil or water. These include the fire department training areas, LF-6, and several locations within the IS/PA.

Limited specific conclusions could be drawn regarding the presence or absence of hazardous substances based on the screening protocol. Other analytes are discussed in the following subsections of this report. Site-by-site contamination profiles, taking into account the entire analytical protocols, are addressed in Section 4.4 of this report.

4.3.3.2 Interpretative Results - Cyanide and Phenols

Phenols are compounds found in the heavier fractions of petroleum products, coal tars, and in some cleaning compounds with petroleum distillate components. They are not generally found occurring naturally outside these materials unless a man-made source is nearby. Background levels are, therefore, expected to be zero in areas unaffected by human activities. Detection of phenols at Pease AFB was expected to indicate contamination by petroleum products, fuels, or cleaning compounds, but a strong, positive correlation of phenol results with oil and grease results was generally poor.

The particular analytical method used for samples at Pease AFB is subject to interferences from sulfur compounds, oils, and tars. Phenol levels slightly above the method detection limit of 0.005 mg/l were commonly observed in the samples. These levels were considered to represent interferences, and, for interpretive purposes, background phenol levels were defined as ranging between 0.005 and 0.01 mg/l.

It should be noted that the required detection limit of 0.001 mg/l for phenols in water was not met for lab samples. The required analytical method had a method detection limit of 0.005 mg/l, which was achieved.

Phenols were found in fifteen monitoring wells and eleven surface water samples in concentrations in excess of the State MCL and the water quality criteria set for domestic water supplies (0.001 mg/l). The levels cited ranged from none detected to 0.454 mg/l and reflect the total concentration of phenolic compounds.

The concentration of 0.001 mg/l for the MCL and quality criteria for domestic water was established as an aesthetic standard because low levels of certain phenolic compounds can adversely affect the taste and odor of chlorinated drinking water and have also been shown to taint the flesh of freshwater fish. The EPA has established a recommended human consumption level for phenol of 3.5 mg/l based upon available toxicity data (Federal Register, 1980). None of the water samples collected at Pease AFB exceeded the 3.5 mg/l toxic level for human consumption.

Field blanks were prepared during each round of the groundwater sampling, one on 12 August 1985 (RFW-38), one on 21 March 1985 (RFW-39) and one on 7 May 1985 (RFW-40), for QA/QC purposes. In the latter two cases, the blanks exhibited phenol concentrations above the MCL; however, no other samples collected on those days contained concentrations above the MCL. It is likely that the phenols present in these two blanks were caused by background noise (i.e., laboratory artifacts, contaminated glassware, or field sampling error) or other interferences and that low level concentrations in other samples from that round may be similarly affected. At eighteen of the twenty-six locations where phenol analyses exceeded the MCL, second round samples failed to detect phenol. While such changes in surface water grab samples may be attributable to temporal variations in flow, it is unlikely that groundwater quality would show such large variations.

Of the six surface and groundwater sampling locations where phenol was detected in both sampling rounds, three are located at LF-6. Wells RFW-33, RFW-34, and RFW-35 each contained phenol in both rounds at levels ranging from 0.033 to 0.454 mg/l. These values are generally one to two orders of magnitude higher than found elsewhere on the base and within one order of magnitude of the toxic limit of 3.5 mg/l discussed above.

In summary, phenols were commonly found throughout the base in concentrations which exceeded the State MCL of 0.001

mg/l. In all cases except wells RFW-34 and RFW-35 at LF-6 shown on Figure 3-10, the concentrations found were at least two orders of magnitude below the toxic limit and are concluded to represent no human health threat. The concentrations found in RFW-34 and RFW-35 are within one order of magnitude of the toxic limit and are considered elevated with respect to human health and the environment. The interpretation of phenol results with respect to other analyses of surface and groundwater is discussed on a site by site basis in Section 4.4.

Cyanide analyses were performed on 21 samples from Zone 1 and Zone 2. One sample, SW-3, from Zone 1 exhibited a cyanide concentration of 0.02 mg/l in a second round sample. This concentration is slightly above the State MCL of 0.01 mg/l. The first round sample from SW-3 exhibited no detectable levels of cyanide. All the cyanide analyses were below the State MCL. Based on the State MCL and the EPA toxic level for human consumption (0.2 mg/l) as described in the November 1980 Federal Register, no cyanide related environmental problems were detected in base groundwater or surface waters.

4.3.3.3 Interpretive Results - Metals

Heavy metals samples were selectively analyzed for up to 12 specific metals by atomic absorption spectrophotometry. This method may be subject to interferences from the sample matrix, although such interference is more common in complex matrices such as soils and sediments. In addition, heavy metals are present in soils at natural levels characteristic of a given region and its geology. Typical natural background levels for soils of North America are summarized in Table 4-4 and must be considered in the evaluation of results for soil samples.

The objective of water sample analysis at Pease AFB was to quantify dissolved heavy metals. The presence of suspended sediment in the water samples could have resulted in inaccurately high results, because of the minerals in soils. Therefore, all groundwater samples were filtered to remove any suspended sediments agitated during purging. Water quality criteria have been established for the various heavy metals and provide the most important context for evaluating the metals results (Table 4-7).

TABLE 4-7
COMPARISON OF WATER QUALITY CONSTITUENTS
WITH WATER QUALITY GUIDANCE CRITERIA AND STANDARDS

Parameter	Reporting Unit Detection Limit	(A) New Hampshire Federal Standard	(B) Proposed MCL	(C) Water Quality Critera Documents	Wells and Surface Water Exceeding the Criteria or Standards Under Columns A, B, or C
Cyanide	0.02 mg/L	.01	--	0.2	none
Phenols	0.005 mg/L	.001	--	3.5	RFW-7,8,38,30,31,19,22,23,24,29,40,32,33,34,35 (A); SW-2,3,6,8,9,14,16,24,26,27,28 (A)
Iron	0.05 mg/L	0.3	--	--	RFW-5,7,8,9,38,29,30,31,18,20-23,32-35 (A); SW-2-9,13-16,19-22,31,24-29 (A)
Copper	0.01-0.02 mg/L	1.0	--	1.0	SW-21 (A)
Cadmium	0.01 mg/L	0.01	--	0.006 ug/l	RFW-29 (A,C); SW-4, (A)
Chromium (Total)	0.01-0.05 mg/L	0.05	--	0.05	none
Lead	0.005-0.20 mg/L	0.05	--	0.05	SW-4,7,8,15 (A,C) PW-5
Arsenic	0.01 mg/L	0.05	--	0.2 ug/l	RFW-30,31,34 (A,C) SW-2,3,7 (A,C)
Nickel	0.4-0.1 mg/L	--	--	0.0134	RFW-18-24,40,29,30,31,33 (C)
Silver	0.0025-0.10 mg/L	--	--	--	none
Zinc	0.01-0.20 mg/L	5.0	--	5.0	none
Selenium	0.005-0.10 mg/L	--	--	--	none
pH	0.12 s.u.	6.5-8.5	--	--	(1)
Oil & Grease	0.1 mg/l	--	--	--	(2)
2,4,-D	0.5 ug/l	100	--	--	none
DDT	0.5 ug/l	--	--	0.24 ng/l	SW-7,16
Lindane	0.20 ug/l	4.0 (1)	.40	0.19	none
Carbon Tetrachloride	2.0 ug/l	20 (2)	5.0	0.4	none
1,1-Dichloroethylene	2.0 ug/l	70 (2)	7.0	0.033	none
Methylene Chloride	3.0 ug/l	150 (2)	--	--	none
Tetrachloroethylene	2.0 ug/l	40 (2)	--	0.8	RFW-21 (C)
1,1,1-Trichloroethane	2.0 ug/l	1000 (2)	200	--	none
Trichloroethylene	2.0 ug/l	75 (3)	5.0	2.7	PW-3 (C)
Benzene	2.0 ug/l	350	5.0	0.66	none
Vinyl Chloride	4.0 ug/l	--	1.0	2.0	none
1,2-Dichloroethane	2.0 ug/l	--	5.0	0.12	none
p-Dichlorobenzene	3.0 ug/l	--	750	400	none
Xylene	2.0 ug/l	620 (2)	--		none
Chloroform	2.0 ug/l	100 (4)	--	0.19	PW-5,6 (C)
Dichlorobromomethane	2.0 ug/l	100 (4)	--	0.19	PW-6 (C)
Chlorodibromomethane	2.0 ug/l	100 (4)	--	0.19	PW-6 (C)

A - State of New Hampshire Water Supply and Pollution Control Commission, December 1983, Drinking Water Regulations.
B - U.S. EPA, July 1976, Quality Criteria for Water (Guidance for domestic water supplies based on health and welfare considera
C - U.S. EPA, November 1980, Water Quality Criteria Documents, 40 CFR 141.12.
(1) - 10-day SNARL
(2) - Lifetime SNARL
(3) - 7-day SNARL
(4) - Total trihalomethanes, applies to chlorinated water supplies only.

NOTES:
- PW-3 refers to Haven Well
- PW-5 refers to MMS-Z Well
- PW-6 refers to Loomis Well
- A,B,C, after sampling locations indicates which particular criterion was exceeded

Several priority pollutant metals were detected in surface water and groundwater samples from Pease AFB in concentrations exceeding MCLs and/or Water Quality Criteria. Those priority pollutant and non-priority pollutant metals that exceeded any of the three standards cited in Table 4-7 are addressed below.

Iron is a common constituent of rocks and soil and, is naturally occurring in most waters. The State and Federal MCLs are set primarily on an aesthetic or organoleptic basis. Concentrations greater than 0.3 mg/l can cause staining of plumbing and laundry, encrustation of well screens and pipes and produce an objectionable taste in drinking water. Natural dissolved iron concentrations of up to 0.23 mg/l were measured in water from ice-contact deposits in Rye, New Hampshire by Bradley and Petersen, (1962) and swamp waters may contain up to several mg/l of naturally occurring iron (EPA, 1976). Iron concentrations in water that are above ambient levels are frequently indicative of landfill leachate or other sources of organic contamination which result in the mobilization of iron and other metals within the soil and rock matrix.

At Pease AFB monitoring well samples from RFW-29, RFW-31, RFW-34, and RFW-35 and surface water samples from SW-2, SW-3, SW-4, SW-7, SW-8 and SW-9 all contained concentrations of iron (0.5-46.4 mg/l) above standards (Table 4-7) in both rounds of samples. In each case, the sample was taken from a location associated with landfilling operations.

Samples from SW-13, SW-26, SW-27, SW-28, SW-29, and SW-31 all contained levels of iron in excess of the MCL during both sampling rounds (0.32-11.3 mg/l), but each was taken from swampy or boggy wetland areas indicating that the concentrations may be due to natural sources rather than landfilling activities. Therefore, iron by itself is not necessarily a positive indicator of landfill contamination. This was taken into account when interpreting the contamination profile for each site.

Copper was not detected above the MCL in any of the groundwater samples. Copper was detected above the MCL of 1.0 mg/l in one surface water grab sample from SW-21 in Grafton Ditch (Figure 3-14). A second round sample collected from the same location was well within the MCL.

Cadmium was detected in two water samples (RFW-29, and SW-4) at levels exceeding the State and Federal MCL of 0.01 mg/l. The highest result (0.11 mg/l) was detected in a field blank (RFW-38). Because a field blank exhibited the most elevated concentration of cadmium, the presence of this analyte was not used in the interpretation of contamination profiles for the sites.

Concentrations of lead, in excess of the 0.05 mg/l MCL established as Federal and State regulations, were detected in samples from SW-4, SW-7, and SW-8 in Zone 1 from SW-15 from Lower Peverly Pond in Zone 2 and from the MMS-2 well (PW-5). Second round samples from these sampling locations contained lead concentrations below the MCL.

Nickel was found in eleven groundwater samples in concentrations exceeding the 0.0134 mg/l Water Quality Criteria (column 3 on Table 4-7). All samples exhibiting elevated levels of nickel were collected during the second round. All samples contained level of nickel within a range of 0.20 to 0.32 mg/l. A field blank labeled RFW-40 was analyzed with the eleven samples cited above and was found to contain 0.19 mg/l of nickel. The source of nickel in the field and control samples is unknown. Because it was detected in elevated concentrations in a field blank, the presence of nickel was not used as a signature parameter in the assessment of contamination profiles.

Table 4-4 lists common ranges of metals concentrations found in soils in North America. Data from this table were used to interpret the analytical results of soil samples from the IS/PA, and the LFTS. Generally, the soil samples contained typical background concentrations of metals. The exceptions are associated with small areas of suspected contamination found throughout the base. Table 4-4 was used for guidance in the interpretation of soils results. These are discussed on a site-by-site basis in Section 4.4 of this report.

4.3.3.4 Interpretive Results - Priority Pollutant Organics

Volatile organic compounds are man-made and associated with human activities and uses. Therefore, they are not found in areas uaffected by man, and natural background levels are

expected to be zero in soil, surface waters, and groundwaters.

Because of their volatility, VOC are often difficult to sample, especially when present at low levels. They are easily driven off in the sampling process, or introduced as cross-contamination in sampling, storage, transport, or analysis. In analysis of VOC samples, interferences from the sample matrix are possible, although more common in soils than water, resulting in erroneous identification and quantification of individual compounds or masking detection of the presence of one or more compounds. This problem was countered by the analysis of reference standard solutions of known identity and concentration to confirm identification of specific compounds and assist in quantification. Detection of compounds above certain levels triggered reanalysis of the sample on a second column to confirm identity. Analysis of duplicates of selected VOC samples was also performed as a further quality control measure. Field, trip, and laboratory blanks were used to screen out matrix interferences, contamination introduced to the sample after collection, and contamination of laboratory equipment. These measures generally reduce the likelihood of analytical errors to a very low probability. The results for individual VOC compounds are reported for each site in Subsection 4.4.

Low concentrations of methylene chloride and chloroform were detected in several soil and groundwater analyses. These were suspected to be attributable to laboratory artifacts and were evaluated in consideration of all volatile organic results and other supporting analytical data.

4.4 SITE INTERPRETIVE RESULTS

4.4.1 Fire Department Training Area No. 2 - Site 8

4.4.1.1 Hydrogeologic Conditions - FDTA-2

A total of ten test pits and six monitoring wells were installed at FDTA-2 (Figures 3-3 and 3-4). Geologic logs indicate that relatively thin (6 to 40 feet) deposits of fine to coarse sands and gravel (kame deposits) were found to overlie fractured bedrock, separated in places by thin, discontinuous till deposits. Bedrock refusal was encountered at approximately 6.5 feet below ground surface in test

pit 8-TP-8 and at 37 feet below ground surface in monitoring well RFW-11, indicating that surficial deposits, particularly the till, increase in thickness from east to west. A bedrock ridge, located just east of the site (Figure 4-4), trends toward the northeast and is believed to control local groundwater flow. Bedrock cuttings and core samples from RFW-11 through RFW-15 show the area to be underlain by moderately fractured gray slates and schists of the Eliot Formation.

The shallow groundwater flow zone is comprised primarily of kame deposits. The direction of groundwater flow through the site is predominantly toward the west-southwest, perpendicular to a line drawn through RFW-10 and RFW-11, along a gradient of approximately 0.012 feet per foot. Based on preceding discussions, a reasonable range of hydraulic conductivity for the kame deposits encountered at FDTA-2 would be 1 to 100 ft/day. Using an average hydraulic gradient of 0.012 and assuming a porosity of 0.30 (typical for sand and gravel), the estimated linear groundwater flow velocity beneath FDTA-2, from equation 4.1 above, is between 0.04 and 4 ft/day, or between about 15 and 1500 ft/year. Using the conservative assumption that contaminants travel at a rate equal to groundwater velocity, water quality constituents from this site may have moved between 375 and 37,500 feet away from the burn area since the beginning of site operations in 1961. The base boundary and Peverly Brook are within this area of potential effects.

The estimated volume of groundwater flow within the high permeability sands and gravels beneath the site can be computed using an average saturated thickness for the unconsolidated aquifer of 10 feet and a flow path width of 800 feet. This yields a cross-sectional area of 8,000 square feet and, from equation 4.2, the volumetric flow beneath the site can be estimated to be between 96 to 9,600 cubic feet per day, or approximately 700 to 70,000 gallons per day. Additional flow in the till and fractured bedrock would likely occur at a lower rate, but would have the potential for transporting contaminants off-base.

4.4.1.2 Soil Sampling Results FDTA-2

Six soil samples were collected from test pits excavated in an area of stained soil located northeast of FDTA-2 (Figure 3-3). This area has historically received runoff from the burn area. Examination of *in situ* soils showed that

stains extended as deep as nine feet below land surface in 8-TP-10 in the center of the stained area. All six samples were collected from the upper two feet of the unconsolidated material and analyzed for TOX and oil and grease (O&G) to evaluate the significance of contamination in obviously stained soils. Results are reported in Table 4-8. The TOX analyses ranged from "none detected" to 0.30 mg/kg, and the oil and grease results varied from 37 mg/kg to 5790 mg/kg. The TOX concentration indicated that chlorinated organics may be present in the soils at the FDTA-2 in low concentration. O&G levels in Test Pits No. 8-TP-2, 8-TP-4, 8-TP-6, and 8-TP-9 may indicate the presence of other components of JP-4 and AVGAS both of which have been used extensively at the site in the fire department training operations.

The probable presence of volatile organic compounds in the soil is further indicated by the results of field screening of soil samples and ambient air conditions with an HNu model PI 101 photoionization detector (HNu). Downhole field measurements were not recorded with the HNu. Field readings as high as 25 parts per million (ppm) above background levels were measured in the breathing zone above 8-TP-10. Field personnel, also noted a petroleum-like odor in the ambient air while excavating the test pits.

4.4.1.3 Groundwater Results - FDTA-2

The analytical results of groundwater samples from RFW-10 through RFW-15 are presented on Table 4-9. The field testing results are illustrated on Table 3-6. Two of the five wells (RFW-10 and RFW-11) indicated some evidence of impacts attributable to past site use. For example, both rounds of TOX results from RFW-10 were comparatively elevated with respect to anticipated background conditions. The Oil and Grease results from RFW-10 were also in the low to elevated range. The 134 mg/l O&G result for the second round sample from RFW-10 was confirmed with the laboratory. A review of the sampling and analytical protocols as well as the field testing results did not reveal an explanation for this anomalously high result. The background levels of TOC detected in RFW-10 did not correspond with the low to elevated concentrations of O&G and TOX in the well samples.

An agitated water sample collected on 1 May 1985, as RFW-11 was being purged, exhibited approximately 15 ppm of total volatile organics on the HNu. A similar sample from RFW-12

WESTON

Table 4-8

ANALYTICAL RESULTS - SOILS

FDTA 2

Detection Limit and Reporting Unit	TOX	Oil & Grease
	0.1 mg/kg	5-7 mg/kg
Date of Sampling	10/25-26/85	10/25-26/85
8-TP-1	0.01	37
8-TP-2	0.03	199
8-TP-4	nd	2180
8-TP-6	nd	386
8-TP-8	nd	237
8-TP-9	0.01	5790

nd = None Detected

TABLE 4-9

ANALYTICAL RESULTS - GROUNDWATER

FDTA 2

Well Number	RFW-10		RFW-11		RFW-12	
Sampling Date	3/21/85	5/1/85	5/1/85	12/18/85	5/1/86	1/27/86
TOX	359	140	27	22.9	6	ND
TOC	9.6	1.2	39.4	20.9	0.8	1.35
Oil & Grease	1.61	134	2.09	2.00	0.86	ND

Well Number	RFW-13		RFW-14		RFW-15		RFW-36
Sampling Date	3/21/85	5/1/85	3/21/85	5/1/85	3/21/85	5/1/85	3/22/85
TOX	10	8	6	5	10	12	nd
TOC	3.2	3.3	1.8	1.6	1.4	1.3	1.4
Oil & Grease	0.53	2.13	0.20	0.26	0.18	0.31	nd

NOTES: DETECTION LIMITS AND REPORTING UNITS

TOX = 5 ug/l
TOC = 0.5 mg/l
O&G = 0.1 mg/l
nd = None Detected
RFW-36 is a field blank

registered 0.2 ppm above background readings. Furthermore, during installation of the wells, HNu screening of the boring for RFW-11 produced readings of as high as 40 ppm. Similar screening procedures at RFW-12 registered no readings above background. The analytical results for RFW-11 and RFW-12 contained inconsistencies between the March 1985 abd the May 1985 results. It was suspected that the labelling of samples for RFW-11 and RFW-12 were reversed during the March 1985 sampling round. To resolve this question, wells RFW-11 and RFW-12 were resampled in January 1986. The January 1986 results for RFW-11 and RFW-12 closely correlated with the May 1985 results. Therefore, the suspect March 1985 results for those wells were omitted from Table 4-9. The results are included in Appendix H.

Analytical results for wells RFW-13, RFW-14 and RFW-15 were detected at background concentrations with the exception of a slightly elevated O&G concentration in one sampling round of RFW-13.

4.4.1.4 <u>Contamination Profile - FDTA-2</u>

The FDTA-2 has historically received large quantities of waste fuel as part of ongoing fire department training exercises. Much of the fuel was burned during the operations but some is concluded to have migrated downward into the high permeability stratified kame plain deposit sands and gravel beneath the site and overland to a lowlying area northeast of the training area. Visual examination of soils during test pit excavations; field screening of air, soil, and water; and laboratory analyses of soil and groundwater samples indicates that contamination exists on and beneath the site. It is estimated that up to 5,000 cubic yards of soil material may be contaminated with oily wastes from FDTA-2. This is based on an area of stained soils encompassing approximately 0.5 acre and extending to an average depth of at least five feet.

Static water levels in the six monitoring wells indicate that groundwater flow is toward the south and west of the active site in the direction of RFW-10 and RFW-11. These wells are within 800 feet of the base boundary. Contaminant levels of TOX (351 and 140 ug/l) and O&G (1.6 and 134 mg/l) in RFW-10 are elevated, and suggest that a contaminant plume is moving toward the base boundary, approximately 800 feet away. In addition, kame deposits directly overlie fractured bedrock, allowing for the possibility of contamination migration to deeper flow zones.

4.4.2 Zone 1, Bulk Fuel Storage Area - Site 13, and Landfills 2, 3, 4 and 5 - Sites 2, 3, 4 and 5

A total of nine groundwater monitoring wells and eight surface water locations were sampled in this zone (Figure 3-5). Well RFW-1 through RFW-4 were installed to monitor groundwater at the Bulk Fuel Storage Area; wells RFW-5, RFW-6, and RFW-8 were spatially arranged to provide upgradient monitoring for the four landfills. Wells RFW-7 and RFW-9 serve as downgradient wells for the landfills. The eight surface water sampling sites were chosen to detect degradation of water quality as the streams flow past the sites in question (Figure 3-5). Each surface water site and well was sampled twice; analytical results appear in Tables 4-10 and 4-11.

4.4.2.1 Hydrogeologic Conditions - Zone 1, BFSA and LF-2 through LF-5

Zone 1 is located in the northern corner of the base. Nine monitoring wells were installed and surface water samples were collected at nine locations within the zone (Figure 3-5). Soil samples obtained during the well drilling operations indicate that the area has a complex geologic history. Surficial deposits are relatively thin, varying from six feet at RFW-8 to twenty-five feet at RFW-2. Glacial till between 3 and 21 feet in thickness was found overlying bedrock in wells RFW-1, RFW-2, RFW-3, RFW-4, RFW-5, RFW-6, and RFW-9. Marine clays were encountered above the till deposits in RFW-1 and RFW-9, while kame deposits of sand and gravel were found above the till in RFW-2, RFW-3, RFW-4, and RFW-8. Till only was found in RFW-5 and kame deposits only were found in RFW-6 and RFW-7 overlying bedrock. The marine clays probably pre-date the kame deposits since sands and gravels were found above clay deposits in RFW-1. Bedrock beneath the site is primarily gray slate and schist of the Eliot Formation. It appears to be moderately to highly fractured and weathered, particularly in the core samples from RFW-2.

By examining Figure 4-5 and constructing approximate groundwater flow lines through the BFSA and LF-2 through LF-5, it becomes apparent that a groundwater divide crosses the zone, so that flow diverges in two directions. Flow from the BFSA, LF-2, and portions of LF-5 is easterly, paralleling the flow direction of Paul's Brook, which passes near the BFSA. The remainder of the groundwater flow is north-

TABLE 4-10

ANALYTICAL RESULTS - GROUNDWATER

ZONE 1

BFSA, LF-2, LF-3, LF-4 and LF-5

Well Number	RFW-1		RFW-2		RFW-3	
Sampling Date	3/19/85	4/29/85	3/19/85	4/29/85	3/19/85	4/29/85
TOX	20	17	36	36	nd	nd
TOC	3.7	2.7	3.1	4.1	0.8	0.9
Oil & Grease	1.97	0.61	0.26	0.52	0.31	0.49

Well Number	RFW-4		RFW-37	
Sampling Date	3/19/85	4/29/85	3/19/85	8/7/85
TOX	6	5	nd	
TOC	1.6	2.1	1.1	
Oil & Grease	0.38	0.34	#	nd

NOTES: Detection Limits and Reporting Units

TOX = 5 ug/l
TOC = 0.5 mg/l
O&G = 0.1 mg/l
nd = None Detected
# = Resampled dup to quality control or lost sample

TABLE 4-10 (Cont.)

ANALYTICAL RESULTS - GROUNDWATER

ZONE 1

BFSA, LF-2, LF-3, LF-4 and LF-5

Parameter	Detection Limit & Reporting Unit	RFW-5				RFW-6			RFW-7		
		3/22/85	4/29/85	8/9/85	9/5/85	3/19/85	4/29/85	8/7/85	3/20/85	4/29/85	8/15/85
TOX	5 ug/L	18	11	--	--	19	28	--	7	40	--
TOC	0.5 mg/L	0.8	1.0	--	--	2.1	1.7	--	2.5	3.2	--
Oil & Grease	0.1 mg/L	nd	0.[illegible]8	--	--	nd	0.32	--	nd	nd	--
Cyanide	0.01-0.02 mg/L	#	#	nd	nd	nd	nd	--	nd	nd	--
Phenol	0.005 mg/L	nd	nd	nd	nd	nd	nd	--	0.011	nd	--
Arsenic	0.01 mg/L	nd	nd	--	--	nd	nd	--	nd	nd	--
Barium	0.01-0.02 mg/L	nd	nd	--	--	nd	nd	--	nd	nd	--
Cadmium	0.003-0.01 mg/L	nd	nd	--	--	nd	nd	--	nd	nd	--
Chromium(Total)	0.01-0.05 mg/L	nd	0.02[illegible]	--	--	nd	0.022	--	nd	0.026	--
Copper	0.01-0.02 mg/L	nd	0.1	--	--	nd	0.076	--	0.085	0.065	--
Iron	0.5-0.05 mg/L	0.62	0.19	--	--	[illegible]	0.26	--	1.5	0.06	--
Lead	0.005-0.02 mg/L	0.014	nd	--	--	nd	nd	--	0.024	nd	--
Nickel	0.04-0.1 mg/L	nd	nd	--	--	nd	nd	--	nd	nd	--
Mercury	0.0005-0.001 mg/L	0.0006	nd	--	--	0.0012	nd	--	nd	nd	--
Selenium	0.005-0.01 mg/L	nd	nd	--	--	nd	nd	--	nd	nd	--
Silver	0.0025-0.01 mg/L	nd	nd	--	--	nd	nd	--	nd	nd	--
Zinc	0.01-0.02 mg/L	nd	0.017	--	--	0.05	nd	--	0.05	0.014	--
Detected Pesticides & Herbicides											
Lindane	0.02 ug/L	nd	#	nd	nd	0.38	#	nd	0.56	#	nd

nd- none detected

- resampled due to quality control or lost sample

- Parameter not specified

TABLE 4-10 (Cont.)

ANALYTICAL RESULTS - GROUNDWATER

ZONE 1

BFSA, LF-2, LF-3, LF-4 and LF-5

Parameter	Detection Limit & Reporting Unit	RFW-8 3/20/85	RFW-8 4/29/85	RFW-8 8/7/85	RFW-9 3/20/85	RFW-9 4/30/85	RFW-38 3/21/85	RFW-38 8/12/85
TOX	5 ug/L	83	7	--	nd	11	23	9
TOC	0.5 mg/L	3.0	2.4	--	0.6	0.8	1.0	1.9
Oil & Grease	0.1 mg/L	0.76	0.36	--	0.15	0.14	nd	0.27
Cyanide	0.01-0.02 mg/L	nd	nd	--	nd	nd	nd	nd
Phenol	0.005 mg/L	0.005	nd	--	nd	nd	0.005	nd
Arsenic	0.01 mg/L	nd	nd	--	nd	nd	nd	nd
Barium	0.01-0.02 mg/L	nd	nd	--	nd	nd	nd	nd
Cadmium	0.003-0.01 mg/L	0.004	nd	--	nd	nd	nd	0.11
Chromium(Total)	0.01-0.05 mg/L	nd	0.026	-	nd	nd	nd	nd
Copper	0.01-0.02 mg/L	0.08	0.055	--	nd	nd	nd	nd
Iron	0.5-0.05 mg/L	5.33	0.18	-	0.26	0.32	0.05	8.3
Lead	0.005-0.02 mg/L	0.03	nd	--	nd	nd	nd	nd
Nickel	0.04-0.1 mg/L	nd	nd	--	nd	nd	nd	nd
Mercury	0.0005-0.001 mg/L	0.0009	nd	--	nd	nd	nd	nd
Selenium	0.005-0.01 mg/L	nd	nd	--	nd	nd	nd	nd
Silver	0.0025-0.01 mg/L	nd	nd	--	nd	nd	nd	0.054
Zinc	0.01-0.02 mg/L	0.07	nd	--	0.03	nd	nd	0.02
Detected Pesticides & Herbicides								
Lindane	0.02 ug/L	nd	#	nd	0.32	nd	0.22	nd

nd- none detected

- resampled due to quality control or lost sample

RFW-38 is a field blank

TABLE 4-11

ANALYTICAL RESULTS - SURFACE WATER
ZONE 1

BFSA, LF-2, LF-3, LF-4 and LF-5

Parameter	Detection Limit & Reporting Unit	SW-1 11/8/84	SW-1 3/11/85	SW-1 8/6/85	SW-2 11/8/84	SW-2 3/11/85	SW-2 8/6/85	SW-3 11/8/84	SW-3 3/11/85	SW-3 8/6/85
TOX	5 ug/L	29	50	--	42	15	--	35	13	--
TOC	0.5 mg/L	4.0	3.3	--	20.3	11	--	25.2	9.0	--
Oil & Grease	0.1 mg/L	#	0.15	0.11	#	0.53	0.33	#	0.15	1.31
Cyanide	0.01-0.02 mg/L	--	--	--	#	nd	nd	#	nd	0.02
Phenol	0.005 mg/L	--	--	--	0.006	0.006	--	0.006	nd	--
Arsenic	0.01 mg/L	--	--	--	0.08	0.012	--	0.05	nd	--
Barium	0.01-0.02 mg/L	--	--	--	0.04	nd	--	0.05	nd	--
Cadmium	0.003-0.01 mg/L	--	--	--	nd	nd	--	nd	nd	--
Chromium (Total)	0.01-0.05 mg/L	--	--	--	nd	nd	--	nd	nd	--
Copper	0.01-0.02 mg/L	--	--	--	0.16	0.065	--	0.07	0.057	--
Iron	0.5-0.05 mg/L	--	--	--	46.4	2.59	--	16.8	0.66	--
Lead	0.005-0.02 mg/L	--	--	--	0.04	nd	--	0.048	nd	--
Nickel	0.04-0.1 mg/L	--	--	--	nd	nd	--	nd	nd	--
Mercury	0.0005-0.001 mg/L	--	--	--	nd	nd	--	nd	nd	--
Selenium	0.005-0.01 mg/L	--	--	--	nd	nd	--	nd	nd	--
Silver	0.0025-0.01 mg/L	--	--	--	nd	nd	--	nd	nd	--
Zinc	0.01-0.02 mg/L	--	--	--	0.21	nd	--	0.09	nd	--
Detected Pesticides & Herbicides										
Lindane	0.02 ug/L	--	--	--	#	0.6	nd	#	nd	nd

nd- none detected

- resampled due to quality control or lost sample

-- Parameter not specified

Table 4-11 (Cont.)

ANALYTICAL RESULTS - SURFACE WATER
ZONE 1

BFSA, LF-2, LF-3, LF-4 and LF-5

Parameter	Detection Limit & Reporting Unit	SW-4 11/8/84	SW-4 3/11/85	SW-4 8/6/85	SW-4 9/5/85	SW-5 11/8/84	SW-5 8/6/85	SW-6 11/8/84	SW-6 3/11/85	SW-6 8/6/85	SW-6 9/5/85
TOX	5 ug/L	38	22	--	--	nd	--	43	19	--	--
TOC	0.5 mg/L	3.4	3.0	--	--	nd	--	2.7	4.5	--	--
Oil & Grease	0.1 mg/L	#	nd	nd	--	#	nd	nd	nd	--	--
Cyanide	0.01-0.02 mg/L	#	#	nd	nd	#	nd	#	#	nd	nd
Phenol	0.005 mg/L	nd	nd	--	--	nd	--	nd	0.012	--	--
Arsenic	0.01 mg/L	nd	nd	--	--	nd	--	nd	nd	--	--
Barium	0.01-0.02 mg/L	nd	nd	--	--	nd	--	#	nd	--	nd
Cadmium	0.003-0.01 mg/L	0.011	nd	--	--	nd	--	nd	nd	--	nd
Chromium (Total)	0.01-0.05 mg/L	nd	nd	--	--	nd	--	nd	nd	--	--
Copper	0.01-0.02 mg/L	0.039	0.025	--	--	nd	--	nd	nd	--	--
Iron	0.5-0.05 mg/L	4.89	0.32	--	--	nd	--	0.24	0.78	--	--
Lead	0.005-0.02 mg/L	0.07	0.012	--	--	nd	--	nd	nd	--	--
Nickel	0.04-0.1 mg/L	nd	nd	--	--	nd	--	nd	nd	--	--
Mercury	0.0005-0.001 mg/L	nd	nd	--	--	nd	--	0.001	nd	--	--
Selenium	0.005-0.01 mg/L	nd	nd	--	--	nd	--	0.011	nd	--	--
Silver	0.0025-0.01 mg/L	nd	nd	--	--	nd	--	nd	nd	--	--
Zinc	0.01-0.02 mg/L	0.02	nd	--	--	nd	--	nd	nd	--	--
Detected Pesticides & Herbicides											
Lindane	0.02 ug/L	#	nd	nd	--	#	nd	#	0.42	nd	--

-- Parameter not specified.

nd- none detected

- resampled due to quality control or lost sample

SW-5 is a field blank

TABLE 4-11 (Cont.)

ANALYTICAL RESULTS - SURFACE WATER
ZONE 1

BFSA, LF-2, LF-3, LF-4 and LF-5

Parameter	Detection Limit & Reporting Unit	SW-7 11/8/84	SW-7 3/11/85	SW-7 8/6/85	SW-7 9/5/85	SW-8 11/7/84	SW-8 3/11/85	SW-8 8/6/85	SW-8 9/5/85	SW-9 11/8/84	SW-9 3/11/85	SW-9 8/6/85	SW-9 9/5/85
TOX	5 ug/L	19	38	--	--	19	10	--	--	17	19	--	--
TOC	0.5 mg/L	10.4	5.3	--	--	3.5	6	--	--	3.2	5.6	--	--
Oil & Grease	0.1 mg/L	*	0.15	0.12	--	*	nd	0.15	--	*	nd	0.14	--
Cyanide	0.01-0.02 mg/L	*	*	nd	nd	*	*	nd	nd	*	*	nd	nd
Phenol	0.005 mg/L	nd	nd	--	--	0.008	0.005	--	--	0.01	*	nd	--
Arsenic	0.01 mg/L	0.11	0.012	--	--	nd	nd	--	--	nd	nd	--	--
Barium	0.01-0.02 mg/L	nd	nd	--	--	nd	nd	--	--	nd	nd	--	--
Cadmium	0.003-0.01 mg/L	nd	nd	--	--	nd	nd	--	--	nd	nd	--	--
Chromium (Total)	0.01-0.05 mg/L	nd	nd	--	--	nd	nd	--	--	nd	nd	--	--
Copper	0.01-0.02 mg/L	0.1	nd	--	--	0.1	0.01	--	--	0.08	nd	--	--
Iron	0.5-0.05 mg/L	75.1	4.99	--	--	0.36	0.33	--	--	0.34	0.31	--	--
Lead	0.005-0.02 mg/L	0.396	0.012	--	--	0.091	nd	--	--	nd	nd	--	--
Nickel	0.04-0.1 mg/L	nd	nd	--	--	nd	nd	--	--	nd	nd	--	--
Mercury	0.0005-0.001 mg/L	nd	nd	--	--	nd	nd	--	--	nd	0.001	--	--
Selenium	0.005-0.01 mg/L	nd	nd	--	--	nd	nd	--	--	nd	nd	--	--
Silver	0.0025-0.01 mg/L	nd	nd	--	--	nd	nd	--	--	nd	nd	--	--
Zinc	0.01-0.02 mg/L	0.12	nd	--	--	nd	nd	--	--	nd	nd	--	--
Detected Pesticides & Herbicides													
DDT Isomer	0.25 ug/L	*	*	14	9.2	nd	nd	--	--	nd	nd	--	--

nd- none detected

* - resampled due to quality control or lost sample

-- Parameter not specified.

northwest paralleling the flow direction of Flagstone Brook, which is a tributary to Pickering Brook. It is likely that groundwater from the zone discharges to both streams, providing base flow during dry periods.

Groundwater beneath the BFSA was encountered in sands and gravels, till, and bedrock. The thickest saturated stratum was the till; therefore, the majority of the shallow flow is probably through the till. Using the range of permeabilities calculated from slug test data at the site in equation 4.1 probably gives accurate estimates of seepage velocities through the area, since the saturated overburden at RFW-1, the most downgradient well, is primarily silt and clay. Therefore, assuming a hydraulic conductivity range of 0.08 to 2 feet/day, a porosity of 0.30, and a hydraulic gradient of 0.03, the range of seepage velocities is from about 0.01 ft/day to 0.2 ft/day or approximately 3 to 73 ft/year.

Since the base boundary is less than 1000 feet downgradient of the BFSA and the site has been in operation since at least 1959, it is possible that any groundwater contamination resulting from past site activities may have migrated through the unconsolidated deposits to the base boundary or to discharge points along Paul's Brook. Groundwater from the vicinity of LF-2 and the eastern portion of LF-5 also flows to the east and may also discharge to Paul's Brook.

The remainder of the groundwater flow from the zone migrates toward the north, parallel to Flagstone Brook. The six foot thick deposit of sand and gravel found in the upgradient well RFW-8 thins out and was absent in RFW-9, located approximately 800 feet northeast of RFW-8, at the downgradient edge of Zone 1. The primary water-bearing formations are till and marine clays which exhibited a range of hydraulic conductivities of 0.04 to 0.7 ft/day in slug and recovery tests conducted by WESTON. Using a measured hydraulic gradient of .025, an effective porosity of 0.30, and the range of permeabilities noted above, the average seepage velocity is computed to be 0.003 ft/day to 0.06 ft/day or approximately 1 to 22 ft/year. As discussed above, it is likely that a significant amount of groundwater discharges to Flagstone Brook. Iron precipitate found in ditches adjacent LF-5 and red discolored seepage into the Flagstone Brook indicates that leachate is seeping from the landfill into the surface waters.

WESTON

4.4.2.2 Groundwater Results - Zone 1, BFSA and LF-1 Through LF-5

Wells RFW-1 through RFW-4, located around the perimeter of the BFSA, were sampled for the three screening parameters TOX, TOC, and O&G. The TOX results ranged from "none detected" in RFW-3 to 36 ug/l in RFW-2 (somewhat above background as defined in Subsection 4.3.1 above). The TOC results followed a similar pattern ranging from 0.8 mg/l in RFW-3 to 4.1 mg/l in RFW-2. No elevated O&G results were detected in the monitoring wells.

An expanded analytical protocol was applied to the monitoring wells that surround the landfills in this zone. In wells RFW-5 through RFW-9, the TOX levels ranged from "none detected" in RFW-9 to 83 ug/l in RFW-8. The TOX concentration in RFW-8 of 85 ug/l was not supported by corresponding O&G and TOC results. A field blank, RFW-38, sampled on 21 March 1985 contained 23 ug/l TOX or slightly above the background range cited on Table 4-3. The TOC and O&G analyses were low or non-detected. No cyanide was detected in any of the samples. RFW-7, RFW-8, and the field blank identified as RFW-38 contained phenol concentrations of 0.011 mg/l in RFW-7 down to 0.005 mg/l (the reported detection limit for that batch) in RFW-8 and RFW-38 (a field blank). These values are considered low, but they do exceed the State of New Hampshire's maximum concentration level for phenols (0.001 mg/l). This concentration is based on aesthetic rather than health related issues. Metal analyses revealed the presence of mercury and chromium in RFW-5, RFW-6 and RFW-8, and chromium and lead in RFW-7. None of these levels exceeded the EPA or New Hampshire MCLs. The New Hampshire secondary drinking water standard MCL for iron is 0.3 mg/l and is exceeded in RFW-5, 7, and 8. Iron standards are set primarily for aesthetic reasons (taste and odor) and iron generally does not pose a health threat. High iron may be indicative of landfill leachate, however, in the case of the upgradient wells RFW-5 and RFW-8 probably indicate natural conditions. This is concluded based upon field screening results and other laboratory analyses. During the analysis of the first round of groundwater samples for pesticides and herbicides, lindane was detected in samples from RFW-6, RFW-7 and RFW-9, as well as the field blank RFW-38 in concentrations of 0.22 ug/l in the blank to 0.56 ug/l in RFW-7. These levels were well below the New Hampshire MCL for lindane of 4 ug/l. An examinatin of the field and analytical methods did not reveal the probable cause of the presence of TOX and lindane in the field blank (RFW-38).

4.4.2.3 Surface Water Results - Zone 1, BFSA and LF-2 through 5

Surface water sample SW-1, collected from Pauls Brook (Figure 3-5) downstream from the BFSA contained 50 ug/l TOX in the second round sample. An oily sheen was also noted at that time on the surface of the stream. Screening parameters TOC and O&G were not found to be elevated relative to samples taken elsewhere on base. TOX concentrations in samples SW-2 through SW-9, collected during two rounds of surface water sampling from drainage ditches bordering LF-2, LF-3, LF-4 and LF-5, varied from non-detected in SW-8 to 43 ug/l in SW-6. These levels are in the same range of concentrations found elsewhere on base in background samples. Samples from SW-2 and SW-3 collected during the first round of sampling both contained greater than 20 mg/l of TOC. This level is above the background level discussed above, however, second round samples from the same location were 11.0 and 9.0 mg/l, well below the upper limit of background levels. A first round resample for O&G from SW-3 contained 1.31 mg/l, this concentration level was an order of magnitude higher than the second round sample collected on 11 March 1985, and was therefore, considered a transient phenomenon.

Cyanide was found in one sample (SW-3) at a level of 0.02 mg/l, which is above the New Hampshire MCL of 0.01 mg/l. Phenols were found in first round samples at SW-2, SW-3, SW-6, and SW-9 and second round samples at SW-2, SW-6, and SW-8 at levels between 0.005 and 0.012 mg/l. The New Hampshire MCL for phenol is 0.001 mg/l.

Metals analyses detected arsenic at sample locations SW-2, SW-3 and SW-7. Arsenic was detected in both rounds in samples from SW-2 and SW-7, but only the first round samples exceeded the State Drinking Water Standard of 0.05 mg/l. The first round sample from SW-3 exhibited an arsenic level at the state MCL, and the second round sample showed non-detectable arsenic concentrations. Cadmium was detected in one location (SW-4) on one occasion. The result was slightly in excess of the State Drinking Water Standard of 0.01 mg/l. Because cadmium was not detected in any other samples from this zone and a field blank had exhibited the highest concentration of cadmium of all samples collected, the presence of this parameter was not concluded to be significant. Lead was detected in five of the nine sampling locations. At locations SW-4, SW-7 and SW-8 the concentrations exceeded State Drinking Water Standard of 0.05 mg/l on one occasion. Lead was present during both sampling rounds in two of the nine surface water sampling locations (SW-4 and SW-7). Iron was the most common metal present in surface waters. It was detected in seven of the nine surface water sampling locations. The concentrations

of iron detected in surface water samples SW-2 and SW-7 and the presence of rust colored precipitates in ditches adjacent to LF-3 and LF-5 indicate a hydraulic connection between groundwater at the landfills and surface waters in the ditches.

Lindane was detected in two surface water samples (SW-2 and S446) on one occasion, and DDT isomer was detected in both surface water sampling rounds from SW-7. These results were within the state MCL for drinking water. No other pesticides or herbicides were detected at any of the surface water sampling stations around the landfill.

4.4.2.4 Contamination Profile - Zone 1, BFSA and LF-2 through LF-5

Surface water samples SW-2 through SW-7 show a pattern of minor contamination by priority pollutant metals and pesticides possibly emanating from one of the landfills.

The presence of TOX was detected at background concentrations at most surface water and groundwater sampling locations. In one instance (RFW-8), an elevated TOX result was obtained on one sampling occasion. Other screening results for Oil and Grease and TOC were at background concentrations in this sample. The TOX, TOC, and O&G results from surface water and groundwater sampling within this zone did not indicate a significant pattern of contamination attributable to past waste disposal practices at the former landfills.

The fact that pesticide containers were reportedly disposed of in base landfills (Phase I Report, 1984) and that Lindane and DDT isomer have been found in surface waters adjacent to LF-3 and LF-5 further indicates the possibility that leachate from the landfills discharges to the streams.

Phenols were detected in five surface water samples from Zone 2 in concentrations that exceed the State MCL. However, these concentrations were two orders of magnitude below the toxicity limits and, as such, probably do not pose a significant health threat.

At current levels, the only contaminant concentrations of concern found in either the groundwater or surface water is that of DDT isomer. However, an examination of analytical data from SW-9, the most downstream sampling location, on Flagstone Brook, shows that no detectable DDT is exiting the base via the surface water route in this zone.

The BFSA was considered separately from LF-2 through LF-5. The analytical results of the groundwater and surface water

samples indicate no contamination of either as a result of operations of the BFSA, nor do they show signs of contamination emanating from the adjacent landfills.

4.4.3 Zone 2, Fire Department Training Area No. 1 (FDTA-1) - Site 7, and Landfill 1 (LF-1) - Site 1

The investigations at FDTA-1 and LF-1 included the sampling of soil from test pits, and the collection of surface water and groundwater samples. A total of three soil samples and two rounds of samples from four surface water and four groundwater monitoring locations were collected (Figure 3-6). The sites are described below and the analytical results are listed in Tables 4-12 through 4-14.

4.4.3.1 Hydrogeologic Conditions - Zone 2, FDTA-1 and LF-1

Landfill 1 and the FDTA No. 1 were considered together as Zone 2. They are located on opposite sides of McIntyre Road between Upper Peverly Pond on the west and the NW-SE Runway on the east (Figure 3-6). Four monitoring wells and four test pits were installed in the zone to provide stratigraphic data, as well as groundwater and soil quality sampling locations. The depths of the unconsolidated materials range from ground surface at a bedrock outcrop near RFW-30 to 51 feet at RFW-28. Kame plain deposits of fine to coarse sand and gravel underlie the entire site. These deposits reach a depth of 35 feet at RFW-28, thinning toward the west where the topography slopes steeply downward toward Upper and Lower Peverly Ponds. In wells RFW-29 and RFW-31, sand and gravel were encountered to depths of approximately five feet below ground surface. A ten foot stratum of marine clay was found beneath the sand and gravel deposits in RFW-28, RFW-29, and RFW-31. A four to six foot thick layer of clayey till was found in all four wells overlying bedrock.

Bedrock cuttings and core samples from the four wells indicate that the area is underlain by gray schists and slates of the Eliot Formation. Bedrock was encountered at an elevation of approximately 73 feet NGVD in RFW-30. The bedrock surface slopes downward radially to 22 NGVD feet in RFW-29, 35 feet in RFW-31, 44 feet in RFW-28, and 66 feet in RFW-27 which is located in the adjacent Leaded Fuel Sludge Disposal area (Site 10) south of Zone 2.

The water table in RFW-28 was encountered at 21 feet below ground surface. Approximately 15 feet of saturated sand was found, underlain by lower permeability saturated marine clay and clayey till. Water table conditions in RFW-29, RFW-30, and RFW-31 were found only in clays and tills.

Groundwater flow trends generally toward the west/northwest toward Upper and Lower Peverly Ponds (Figure 4-5). A small

WESTON

Table 4-12

ANALYTICAL RESULTS - SOILS

ZONE 2
FDTA 1

	TOX	OIL & GREASE
Detection Limits and Reporting Units	0.1 mg/kg	5 mg/kg
Dates of Sampling	1/8/85	1/8/85
7-TP-1	10	24,400
7-TP-2	1	898

Table 4-13

ANALYTICAL RESULTS - GROUNDWATER

Zone 2

FDTA 1 and LF-1

Parameter	Detection Limit & Reporting Unit	FDTA-1 RFW-28 3/26/85	FDTA-1 RFW-28 5/6/85	FDTA-1 RFW-28 8/8/85	RFW-29 3/26/85	RFW-29 5/7/85	LF-1 RFW-30 3/26/85	LF-1 RFW-30 5/7/85	LF-1 RFW-31 3/26/85	LF-1 RFW-31 5/7/85	LF-1 RFW-41 5/6/85	LF-1 RFW-41 1/1/86
TOX	5 ug/L	5	nd	--	35	20	nd	11	43	17	#	21.5
TOC	0.5 mg/L	1.[illegible]	0.8	--	11.5	9.1	1.9	1.1	15.3	12.5	#	1.63
Oil & Grease	0.1 mg/L	0.51	#	1.5	0.5	0.15	0.5	0.55	0.13	1.62	0.34	--
Cyanide	0.01-0.02 mg/L	--	--	--	nd	nd	nd	nd	nd	#	#	nd
Phenol	0.005 mg/L	--	--	--	0.005	nd	0.01	nd	0.011	nd	--	--
Arsenic	0.01 mg/L		--		0.032	0.025	0.148	nd	0.03	0.115	--	--
Barium	0.01-0.02 mg/L	-	--		0.06	0.06	nd	0.04	0.06	0.09	--	--
Cadmium	0.003-0.01 mg/L	-	--	--	nd	0.012	nd	nd	nd	nd	--	--
Chromium(total)	0.01-0.05 mg/L	--	--	--	nd	0.02	nd	0.013	nd	0.013	--	--
Copper	0.01-0.02 mg/L	-	--	--	nd	0.023	nd	0.026	nd	0.02	--	--
Iron	0.5-0.02 mg/L	--	--	--	4.3	3.32	0.14	0.44	9.95	12.7	--	--
Lead	0.005-0.02 mg/L	--	--	--	nd	nd	nd	nd	nd	nd	--	--
Nickel	0.04-0.1 mg/L	--	--	--	nd	0.22	nd	0.29	nd	0.22	--	--
Mercury	0.0005-0.001 mg/L	--	--	--	nd	nd	nd	nd	nd	nd	--	--
Selenium	0.005-0.01 mg/L	--	--	--	nd	0.032	nd	nd	nd	0.016	--	--
Silver	0.0025-0.01 mg/L	--	--	--	nd	nd	nd	nd	nd	nd	--	--
Zinc	0.01-0.02 mg/l	--	--	--	0.02	0.029	nd	0.02	0.03	0.019	--	--
Detected Pesticides & Herbicides												
2,4-D	0.5 ug/l	--	--	--	nd	nd	nd	nd	1.29	nd	--	--

nd - Not detected

1-Detection limits for VOC's are as stated in EPA methods 601 and 602

#-Resampled due to quality control or lost samples

TABLE 4-14

ANALYTICAL RESULTS - SURFACE WATER
ZONE 2
FDTA 1 and LF-1

Parameter	Detection Limit & Reporting Unit Water	SW-13 11/7/84	SW-13 3/11/85	SW-13 8/6/85	SW-13 9/5/85	SW-13 1/27/86	SW-14 11/7/84	SW-14 3/11/85	SW-14 8/6/85	SW-14 9/5/85	SW-14 1/27/86
TOX	5 ug/L	63	17	--	--	--	38	35	--	--	--
TOC	0.5 mg/L	4.1	7.0	--	--	--	2.6	3.1	--	--	--
Oil & Grease	0.1 mg/L	*	0.43	nd	--	--	*	0.13	nd	--	--
Cyanide	0.01-0.02 mg/L	*	*	*	nd	nd	*	*	*	nd	nd
Phenol	0.005 mg/L	nd	nd	--	--	--	nd	0.005	--	--	--
Arsenic	0.01 mg/L	nd	nd	--	--	--	nd	nd	--	--	--
Barium	0.01-0.02 mg/L	nd	nd	--	--	--	nd	nd	--	--	--
Cadmium	0.003-0.01 mg/L	nd	nd	--	--	--	nd	nd	--	--	--
Chromium (Total)	0.01-0.05 mg/L	nd	nd	--	--	--	nd	nd	--	--	--
Copper	0.01-0.02 mg/L	0.070	0.065	--	--	--	0.12	0.06	--	--	--
Iron	0.5-0.05 mg/L	0.410	1.83	--	--	--	0.25	1.11	--	--	--
Lead	0.005-0.02 mg/L	nd	nd	--	--	--	nd	nd	--	--	--
Nickel	0.04-0.1 mg/L	nd	nd	--	--	--	nd	nd	--	--	--
Mercury	0.0005-0.001 mg/L	nd	nd	--	--	--	nd	nd	--	--	--
Selenium	0.005-0.01 mg/L	nd	nd	--	--	--	nd	nd	--	--	--
Silver	0.0025-0.01 mg/L	nd	nd	--	--	--	nd	nd	--	--	--
Zinc	0.01-0.02 mg/L	0.050	nd	--	--	--	nd	nd	--	--	--
Detected Pesticides and Herbicides											
Heptochlor	0.02 ug/L	*	nd	nd	--		*	0.13	nd	--	
Lindane	0.02 ug/L	*	0.47	nd	--		*	nd	nd	--	

nd - None detected
* - Resampled due to quality control or lost samples
-- - Parameter not specified

TABLE 4-14 (Cont.)

ANALYTICAL RESULTS - SURFACE WATER
ZONE 2
FDTA 1 and LF-1

Parameter	Detection Limit & Reporting Unit Water	SW-15 11/7/84	3/11/85	8/6/85	9/5/85	1/27/86
TOX	5 ug/L	21	28	--	--	--
TOC	0.5 mg/L	3.4	3.0	--	--	--
Oil & Grease	0.1 mg/L	#	0.11	nd	--	--
Cyanide	0.01-0.02 mg/L	#	#	#	nd	nd
Phenol	0.005 mg/L	nd	nd	--	--	--
Arsenic	0.01 mg/L	nd	nd	--	--	--
Barium	0.01-0.02 mg/L	nd	nd	--	--	--
Cadmium	0.003-0.01 mg/L	0.011	nd	--	--	--
Chromium (Total)	0.01-0.05 mg/L	nd	nd	--	--	--
Copper	0.01-0.02 mg/L	0.11	nd	--	--	--
Iron	0.5-0.05 mg/L	0.28	0.32	--	--	--
Lead	0.005-0.02 mg/L	0.053	nd	--	--	--
Nickel	0.04-0.1 mg/L	nd	nd	--	--	--
Mercury	0.0005-0.001 mg/L	nd	nd	--	--	--
Selenium	0.005-0.01 mg/L	nd	nd	--	--	--
Silver	0.0025-0.01 mg/L	nd	nd	--	--	--
Zinc	0.01-0.02 mg/L	nd	nd	--	--	--

SW-32 is a field blank
ND None Detected
Resampled due to quality control or lost samples

- Parameter not specific

TABLE 4-14 (Cont.)
ANALYTICAL RESULTS - SURFACE WATER
FDTA 1 - LF-1

			SW-16			SW-32	
Parameter	**Water**	11/17/84	3/11/84	8/6/85	9/3/85	12/18/85	3/11/85
TOX	5 ug/L	60	42	—	—	—	17
TOC	.5 mg/L	8.0	4.7	—	--	--	ND
Oil and Grease	.1 mg/L	#	0.21	ND	—	—	ND
Cyanide	.01-.02 mg/L	#	#	#	ND	ND	ND
Phenol	.005 mg/L	ND	0.005	—	--	—	ND
Arsenic	.01 mg/L	ND	ND	—	--	—	ND
Barium	.01-.02	ND	ND	—	--	—	ND
Cadmium	.003-.01 mg/L	ND	ND	—	--	—	ND
Chromium	.01-.05 mg/L	ND	ND	—	--	—	ND
Copper	.01-.02 mg/L	0.07	0.096	—	--	—	ND
Iron	.5-.05 mg/L	0.67	2.4	—		—	ND
Lead	.005-.02 mg/L	ND	ND	--	--	—	ND
Nickel	.04-.1 mg/L	ND	ND	—	--	--	NC
Mercury	.0005-.001 mg/L	ND	ND	—	--	--	0.001
Selenium	.005-.01 mg/L	ND	ND	—	--	—	ND
Silver	.0025-.01 mg/L	ND	ND	—	--	--	ND
Zinc	.01-.02 mg/L	0.06	ND	—	--	--	ND
Detected Pesticides and Herbicides							
Heptochlor Epoxide	0.02 ug/L	#	ND	ND	ND	ND	ND
Lindane	0.02 ug/L	#	ND	ND	ND	ND	ND
DDT Isomer	0.5 ug/L	#	0.24	ND	ND	ND	ND

SW-32 is a field blank - Parameter not specific
ND None Detected
 # Resampled due to quality control or lost samples

perennial stream located north of the FDTA-1 flows from the southeast to the northwest, discharging to Upper Peverly Pond. This stream probably receives groundwater flow from the upper sand and gravel stratum beneath the FDTA-1, since vertical flow from kame deposits to bedrock in this area is probably restricted by underlying clays and silts.

LF-1 is located less than 100 feet east of Upper Peverly Pond. No wells were installed through the landfill, but data obtained from well logs RFW-29, RFW-30 and RFW-31 indicate that the site is underlain by a five to ten foot layer of kame sands and gravel, marine clay, and till. Seeps and springs are found along the perimeter of the landfill at the toe of a steep embankment adjacent to surface water sampling location SW-14 (Figure 3-6). Red seepage found along the base of the landfill slope indicates the possibility that groundwater has historically leached material from LF-1 and discharged to Upper Peverly Pond.

4.4.3.2 Soil Sampling Results - Zone 2, FDTA-1 and LF-1

Four test pits were excavated in the high permeability sand and gravel at the FDTA-1. Samples were collected from two pits for laboratory analyses for TOX and oil and grease. Sample results are presented on Table 4-12. A sample collected from 7-TP-1 from a depth of one to two feet contained O&G (24,000 mg/kg) and TOX (10 mg/kg). A sample collected from 7-TP-2 at a depth of one foot contained 898 mg/kg O&G and 1.0 mg/kg TOX. The upper 12 inches of 7-TP-2 were visibly stained and contained black ash-like residue. An HNu photoionization detector was used to screen the soil samples and ambient air for the presence of volatile organic compounds, but no readings above background levels were recorded. The absence of detectable concentrations of volatile organics may, in part, be due to instrument response in the extremely cold field conditions ($<0^{o}C$) at the time of sampling.

4.4.3.3 Groundwater Results - Zone 2, FDTA-1 and LF-1

Groundwater quality results are presented on Table 4-13. Monitoring well RFW-28 was installed at FDTA-1 to assess groundwater quality immediately downgradient of the abandoned site. Two rounds of samples were collected and analyzed for TOC, TOX, and O&G. The second round O&G sample bottle was broken in transit and was resampled on 8 August 1985. Analytical results for the two rounds of samples from RFW-28 exhibited one low level of O&G. No concentrations of any other screening parameters (TOX, TOC, O&G) above expected background levels were observed.

Monitoring wells RFW-29, RFW-30, and RFW-31 were installed around the perimeter of LF-1 (Figure 3-6). Two rounds of samples were collected and analyzed for TOX, TOC, O&G, phenols, iron, priority pollutant heavy metals, and pesticides and herbicides. The TOX levels ranged from "none detected" in the first round sample from RFW-30 to 43 ug/l in the second round sample from RFW-31. The TOC levels varied from typical background levels of 1.1 to 1.9 mg/l in RFW-30 to 21.8 mg/l in downgradient well RFW-29 (Figure 3-6). The 21.8 mg/l TOC concentration in RFW-29 may indicate some effects from past waste disposal practices. This conclusion is supported by low concentrations of TOX (34 ug/l) and elevated total dissolved iron concentrations (4.32 and 3.32 mg/l) in the samples from this well. Potential water quality impacts from former landfilling are also supported by the field specific conductance test values (750 umhos/cm) monitored during each sampling round (Table 3-6). These values indicate the presence of total dissolved solids above expected background ranges 300 (umhos/cm).

Oil and grease was found in low concentrations (1.02 mg/l) in only one well, RFW-31. All other wells in LF-1 had background levels of O&G. RFW-31 also exhibited total dissolved iron concentrations of 9.95 and 12.7 mg/l in two rounds of sampling.

Phenols were detected in all three first round samples from wells RFW-29, RFW- 30, and RFW-31 in concentrations greater than New Hampshire Secondary Drinking Water MCL of 0.001 mg/l. However, none were detected in the second round samples from these three wells. None exceeded the 3.5 mg/l EPA Water Quality Criteria health standard (Table 4-7).

Priority pollutant heavy metal results (Table 4-13) exhibited concentrations of arsenic in RFW-30 and RFW-31 of 0.148 mg/l and 0.114 mg/l. These concentrations exceed the New Hampshire MCL of 0.05 mg/l. Also detected at levels greater than the MCL were selenium in second round samples from RFW-29 and RFW-31, cadmium in the second round sample from RFW-29, and iron in all samples except the first round sample from RFW-30. Barium, copper, nickel, and zinc were detected at concentrations below the MCLs.

The herbicide 2,4-D (2,4-Dichlorophenoxyacetic acid) was found in the first round sample from RFW-31 at a concentration of 1.29 ug/l, well below the MCL of 100 ug/l. No 2-4,D was detected in the second round of samples.

In situ water quality measurements were taken for pH, temperature and specific conductance during the purging of the wells prior to sampling. Of particular note are the specific conductance readings from RFW-29 and RFW-31. In both wells, the 600-700 umhos/cm values indicate the presence of comparatively elevated levels of dissolved solids typically associated with landfill leachate. These values are significantly higher than the 70 to 140 umhos/cm levels in RFW-30, an adjacent well, screened in similar strata.

4.4.3.4 Surface Water Results - Zone 2, FDTA-1 and LF-1

Four surface water samples (SW-13 to SW-16) were taken from Upper and Lower Peverly Ponds to assess potential environmental impacts of contamination from LF-1. Sampling locations are illustrated on Figure 3-6. Sample results are presented on Table 4-14. The TOC and O&G concentrations were consistent with background values found elsewhere at Pease AFB. The TOX concentrations ranged from 17 to 63 ug/l in samples from the four locations. These are also considered in the low or background range (Table 4-3). Coincidentally, a field blank of distilled water contained 17 ug/l. Second round samples from SW-14 and SW-16 contained 0.005 mg/l phenol. All other surface water results for phenols in Zone 2 were "none detected."

The first round of metals analyses from SW-15 contained 0.053 mg/l lead. The second round samples were "none detected" for these parameters. No other lead was detected in any other surface water samples from Zone 2. Iron concentrations exceeded 0.25 mg/l in all samples and were detected at levels up to 2.4 mg/l (second round from SW-16).

The first round of pesticide/herbicide analyses detected 0.47 ug/l of lindane in SW-13, 0.13 ug/l of heptachlor epoxide in SW-14, and 0.24 ug/l DDT isomer in SW-16 samples. No pesticides or herbicides were found in any of the second round samples.

In situ water quality tests for pH and specific conductance (Table 3-6) were typical of clean surface water. During the field sampling program rust colored water was noted standing along and extending slightly into Upper Peverly Pond within 50 feet of SW-15. No flow was noted from the stained area. The discolored water covered an area of approximately 30 feet in diameter. This water appears to

represent groundwater discharge from the landfill area. Sample SW-14 was sampled beyond the stained area to provide a representative sample of potential impacts of the landfill on Upper Peverly Pond. Samples SW-13 through SW-16 and the in situ field analyses did not reveal evidence of impacts attributable to former landfill activities.

4.4.3.5 Contamination Profile - Zone 2, FDTA-1 and LF-1

Analytical results for soil samples at the FDTA-1 revealed evidence (TOX and O&G) of contamination in the upper two feet of the soil profile from past disposal practices. The lateral and vertical extent of the elevated TOX and O&G was not determined. The Phase I study (1984) lists waste fuels, waste oils, and solvents among the substances used in fire department training exercises. Groundwater samples from RFW-28 at the FDTA-1 showed no indication of contamination from the site. This is significant since RFW-28 is immediately downgradient of FDTA-1. RFW-31, which is located remotely downgradient of the FDTA-1 contained concentrations of iron and TOX. Generally, more metals in higher concentrations were found in RFW-28 and RFW-31 than upgradient well RFW-30 (Table 4-13).

Oil and grease results from RFW-31 were moderate to low (<2.0 mg/l). Based on the suite of chemical parameters detected in RFW-31, the elevated specific conductance values (>600 umhos/cm) obtained during sampling of RFW-31, and the apparent variance in specific conductance, TOX and TOC results between RFW-28 and RFW-31, it is concluded that the FDTA-1 is not the probable cause of the iron, TOX and TOC concentrations observed in RFW-31. Landfill LF-1, which is also upgradient of RFW-31, is a more probable source of the water quality conditions noted in RFW-31.

Wells RFW-29 and RFW-31 (Figure 3-6) are located along the base of LF-1 and are within the groundwater flow zone downgradient of the landfill. Samples collected on two occasions from each well contained specific conductance, TOX, and iron above expected background. The presence of these constituents indicates the possible presence of leachate from LF-1 in the groundwater along the base of the landfill.

Arsenic was variously present in wells upgradient and downgradient of LF-1. Therefore, its presence above the MCL

of 0.05 mg/l in wells RFW-30 and RFW-31 on one occasion is not attributed to LF-1.

A concern about potential environmental impacts from LF-1 is its proximity to Upper and Lower Peverly Ponds, which are used recreationally by base personnel for swimming, fishing, and camping. As discussed above, the surface water samples contained low levels of DDT isomer, heptachlor epoxide, and lindane. The presence of TOX, iron, and lindane were noted in SW-13 upgradient of LF-1 in the same or more elevated concentration range as the other surface water samples collected downgradient from LF-1. Thus, because the concentrations of analytes were similar for the upgradient and downgradient surface water samples, it does not appear that LF-1 has any adverse impact on Peverly Pond. None of the analyses to date indicate any significant evidence of contamination by hazardous wastes of either ground or surface water.

4.4.4 Zone 3, Industrial Shops/Parking Apron (IS/PA) - Site 15

Twenty-four power auger borings and seven groundwater monitoring wells were drilled at the IS/PA to assess the extent of soil and groundwater contamination from past handling of hazardous materials. Seventeen soil samples from the auger holes and two groundwater samples from each of the monitoring wells were collected for laboratory analysis. Additionally, two samples (one solid and one liquid) were collected from abandoned waste solvent tanks. Analytical results are shown in Tables 4-15 through 4-17.

4.4.4.1 Hydrogeologic Conditions - IS/PA

Seven monitoring wells and twenty-four power auger borings were installed in the IS/PA to classify the stratigraphy and take soil and water quality samples for laboratory analysis (Figures 3-7 and 3-8). Logs of the wells and power auger borings indicate that much of the shallow natural stratigraphy was altered during construction of the base facilities, roads, parking areas and runways. In the eastern portion of the site, the fill material is underlain by thin deposits of sands and gravels which are interbedded with and grade into marine clays. In RFW-20 blue/gray clays were interbedded with medium sands, and clay layers were found in borings in the vicinity of Buildings 113, 119, 120, 226, and 229. The clay strata were thin toward the west and south,

TABLE 4-15

ANALYTICAL RESULTS

ZONE 3
IS/PA
TANK SAMPLES

Parameter	Detection Limit & Reporting Unit		Building 244 TA-1	Building 113 TA-2
			4/24/85	4/24/85
	Water	Soil	(Liquid)	(Soil)
TOX	5 ug/l	0.1 mg/kg	8,910	nd
TOC	0.5 mg/l	mg/kg	6.2	1340
O&G	0.1 mg/l	5 mg/kg	8.68	10
DETECTED PRIORITY POLLUTANT VOLATILE COMPOUNDS[1]			ug/l	mg/kg
Dichlorodifluromethane			4.0	nd
1,1 Dichloroethane			17.0	nd
Tetrachloroethylene			2.8	nd
Trans-1,2-Dichloroethylene			7,000	2.2
Trichloroethylene			22,000	12.0

nd = none detected

1 = Detection limits for VOCs as stated in EPA Methods 601 and 602

TABLE 4-16

ANALYTICAL RESULTS - SOILS
ZONE 3
IS/PA

		Building 119			Building 113					
	Detection Limit and Reporting Unit	15-B-1		15-B-2	15-B-3	15-B-4	15-B-19		15-B-22	
Parameter	Soil	11/20/85	8/14/85	12/27/84	12/27/84	12/27/84	4/25/85	8/14/85	4/25/85	8/14/85
TOX	0.1 - 5.0 mg/kg	#	67.5	ND	ND	0.11	#	0.2	#	0.3
Oil & Grease	5.0 - 7.0 mg/kg	1800	--	55	27	947	601	--	68	--
Phenol	0.125 mg/kg	#	4.37	ND	ND	ND	#	0.18	#	ND
Arsenic	0.5 - 1.25 mg/kg	#	6.43	16.8	19.0	10.7	#	3.64	#	13.3
Barium	1.0 - 2.0 mg/kg	#	ND	40.0	46.7	34.1	#	ND	#	ND
Cadmium	0.13 - 5 mg/kg	#	ND	3.25	28.7	2.5	#	ND	#	ND
Chromium-Total	1.25 - 5.0 mg/kg	#	ND	22.3	25.2	17.3	#	ND	#	ND
Copper	1.0 - 3.0 mg/kg	#	ND	36.5	39.4	26.8	#	ND	#	ND
Iron	5.0 - 250.0 mg/kg	#	10,300	19,600	23,200	10,200	#	8810	#	15,600
Lead	5.0 mg/kg	#	ND	37.5	44.9	37.5	#	ND	#	ND
Nickel	2.5 - 10.0 mg/kg	#	ND	19.2	18.4	26.8	#	ND	#	ND
Mercury	0.1 - 0.25 mg/kg	#	ND	0.119	0.065	0.051	#	ND	#	ND
Selenium	0.5 mg/kg	#	ND	ND	ND	ND	#	ND	#	ND
Silver	0.13 - 2.5 mg/kg	#	ND	ND	ND	ND	#	ND	#	ND
Zinc	0.5 mg/kg	#	ND	48.0	55.9	30.1	#	ND	#	ND

ND - None Detected
- Resampled due to quality control or lost samples.

TABLE 4-16 (Cont'd)

ANALYTICAL RESULTS - SOILS
ZONE 3
IS/PA

Detected Priority Pollutant Volatile Compounts (1)	Reporting Unit	Building 119			Building 113			
		15-B-1		15-B-2	15-B-3	15-B-4	15-B-19	15-B-22
		11/20/84	8/14/85	12/27/84	12/27/84	12/27/84	4/25/85	4/25/85
Trichloroethylene	mg/kg	#	0.014	nd	nd	0.21	.079	nd
Total Xylenes	mg/kg	#	nd	nd	nd	0.57	nd	nd
Chlorobenzene	mg/kg	#	4.[illegible]	nd	nd	nd	nd	nd
1,2 Dichlorobenzene	mg/kg	#	29.0	nd	nd	nd	nd	nd
1,3 Dichlorobenzene	mg/kg	#	18.0	nd	nd	nd	nd	nd
1,4 Dichlorobenzene	mg/kg	#	19.0	nd	nd	nd	nd	nd
Chloroform	mg/kg	#	0.35	nd	nd	nd	nd	nd
Methylene Chlorine	mg/kg	#	0.25	nd	nd	nd	0.044	nd
Tetrachloroethane	mg/kg	#	0.01	nd	nd	nd	0.012	nd
Toluene	mg/kg	#	3.8	nd	nd	nd	nd	nd
Ethylbenzene	mg/kg	#	7.5	nd	nd	nd	nd	nd

1 - Detection limits for VOC are as stated in EPA Methods 601 and 602
- Resampled due to quality control or lost sample
nd - None detected

TABLE 4-16 (Cont'd)
ANALYTICAL RESULTS - SOILS
ZONE 3
IS/PA

		Building 226				
	Detection Limit and Reporting Unit	15-B-5		15-B-6		15-B-7
Parameter	Soil	4/9/85	9/15/85	4/9/85	9/15/85	4/9/85
TOX	0.1 mg/kg	*	0.2	*	0.6	*
Oil & Grease	5-7 mg/kg	1290	--	21	--	116
Phenol	0.125 mg/kg	0.222	--	0.167	--	0.135
Arsenic	10 mg/kg	0.53	--	0.75	--	1.35
Barium	200 mg/kg	25.5	--	54.6	--	31.2
Cadmium	0.2 mg/kg	nd	--	0.14	--	0.43
Chromium (Total)	5 mg/kg	15.5	--	32.5	--	24.2
Copper	0.4 mg/kg	21.3	--	49.7	--	30.0
Iron	100 mg/kg	9750	--	25600	--	14600
Lead	2 mg/kg	12.4	--	13.9	--	25.2
Nickel	100 mg/kg	5.50	--	18.0	--	11.1
Mercury	0.1 mg/kg	nd	--	nd	--	nd
Selenium	10 mg/kg	nd	--	nd	--	nd
Silver	10 mg/kg	nd	--	nd	--	nd
Zinc	50 mg/kg	22.5	--	55.6	--	34.2
Detected Priority Pollutant Volatile Compounds (1)						
Methylene Chloride	mg/kg	nd	--	0.004	--	nd
Trichloroethylene	mg/kg	nd	--	nd	--	nd
Chloroform	mg/kg	nd	--	nd	--	nd

TABLE 4-16 (Cont'd)

ANALYTICAL RESULTS - SOILS
ZONE 3
IS/PA

Parameter	Detection Limit and Reporting Unit Soil	Building 244 15-B-8 4/9/85	Building 244 15-B-8 9/15/85	Building 244 15-B-9 4/9/85	Building 244 15-B-9 9/15/85
TOX	0.1 mg/kg	#	0.3	#	0.5
Oil & Grease	5-7 mg/kg	nd	--	24	--
Phenol	0.125 mg/kg	0.197	--	0.15	--
Arsenic	10 mg/kg	nd	--	6.23	--
Barium	200 mg/kg	31.2	--	8.50	--
Cadmium	0.2 mg/kg	0.22	--	nd	--
Chromium (Total)	5 mg/kg	8.5	--	7.50	--
Copper	0.4 mg/kg	31.5	--	13.0	--
Iron	100 mg/kg	6600	--	6150	--
Lead	2 mg/kg	14.4	--	6.1	--
Nickel	100 mg/kg	nd	--	8.0	--
Mercury	0.1 mg/kg	nd	--	nd	--
Selenium	10 mg/kg	nd	--	nd	--
Silver	10 mg/kg	nd	--	nd	--
Zinc	50 mg/kg	30.5	--	10.5	--
Detected Priority Pollutant Volatile Compounds (1)					
Methylene Chloride	mg/kg	0.009	--	0.004	--
Trichloroethylene	mg/kg	0.01	--	.004	--
Chloroform	mg/kg	nd	--	.005	--

(1) Detection limits for VOCs are as stated in EPA methods 601 and 602
Resampled due to quality control or lost sample
nd None detected

TABLE 4-16 (cont'd)

ANALYTICAL RESULTS - SOILS
ZONE 3
IS/PA

Parameter	Detection Limit and Reporting Unit Soil		Building 222			Building 234				Building 120		Building 229	
			15-B-10	15-B-11		15-B-15		15-B-17		15-B-18		15-B-24	
			4/9/85	4/10/85	8/14/84	4/23/85	8/14/85	4/23/85	8/14/85	4/27/85	8/14/85	4/25/85	8/14/85
TOX	0.1 - 5.0	mg/kg	0.4	#	0.5	#	0.3	#	ND	#	1.4	#	0.3.
Oil & Grease	5.0 - 7.0	mg/kg	114	691	53	#	ND	#	ND	1460	—	194	
Phenol	0.125	mg/kg	ND	0.228	0.212	#	ND	ND	—	#	5.62	#	0.167
Arsenic	0.5 - 1.25	mg/kg	0.65	5.50	9.53	#	5.7	#	9.22	#	4.33	#	141.0
Barium	1.0 - 2.0	mg/kg	29.5	23.2	ND	#	ND	#	ND	#	ND	#	ND
Cadmium	0.13 - 5	mg/kg	0.160	ND	ND	#	ND	#	ND	#	ND	#	ND
Chromium-Total	1.25 - 5.0	mg/kg	12.5	11.0	ND	#	ND	#	ND	#	130	#	ND
Copper	1.0 - 3.0	mg/kg	20.6	17.0	ND	#	ND	#	ND	#	ND	#	ND
Iron	5.0 - 250.0	mg/kg	10,600.	7,950.	12,600.	#	3,860.	#	7,860.	#	15,300.	#	9,690.
Lead	5.0	mg/kg	8.40	8.80	ND	#	ND	#	ND	#	160	#	ND
Nickel	2.5 - 10	mg/kg	ND	5.20	ND	#	ND	#	ND	#	ND	#	ND
Mercury	0.1 - 0.25	mg/kg	ND	ND	ND	#	ND	#	ND	#	ND	#	ND
Selenium	0.5	mg/kg	ND	ND	ND	#	ND	#	ND	#	ND	#	ND
Silver	0.13 - 2.5	mg/kg	ND	ND	ND	#	ND	#	ND	#	ND	#	ND
Zinc	0.5	mg/kg	25.5	19.7	ND	#	ND	#	ND	#	65.5	#	ND
Detected Priority Pollutant Volatile Compounds (1)													
Chloroform		mg/kg	ND	0.047	—	ND	—	ND	—	ND	—	ND	
Methylene Chloride		mg/kg	0.016	0.004	—	ND	—	ND	—	ND	—	ND	
Dichlorodifluoromethane		mg/kg	0.085	ND	—	ND	—	ND	—	ND	—	ND	

1 - Detection limits for VOC are as stated in EPA Methods 601 and 602
- Resampled due to quality control or lost samples.

TABLE 4-17

ANALYTICAL RESULTS GROUNDWATER
ZONE 5
IS/PA

Parameter	Detection Limit & Reporting Unit	IRW-18 4/3/85	IRW-18 5/7/85	RFW-19 4/3/85	RFW-19 5/7/85	RFW-20 4/3/85	RFW-20 5/7/85	RFW-21 3/22/85	RFW-21 5/2/85	RFW-21 8/9/85	IDW-22 3/22/85	IDW-22 5/4/85	IDW-22 8/9/85
TOX	5ug/L	11	10	5	12	11	27	8	23	—	6	8	--
TOC	0.5mg/L	1.8	0.60	0.90	1.30	1.7	1.7	17.5	0.90	--	6.0	0.80	--
Oil & Grease	0.1mg/L	0.84	0.50	1.60	0.32	1.7	0.50	0.66	1.14	--	0.20	0.35	--
Phenol	0.005mg/L	nd	nd	0.008	nd	nd	nd	nd	nd	--	0.014	nd	--
Arsenic	0.01mg/L	nd	nd	nd	nd	nd	nd	nd	nd	--	nd	nd	--
Barium	0.01-0.02mg/L	0.06	0.26	0.06	0.08	0.06	0.05	nd	nd	--	nd	0.011	--
Cadmium	0.003-0.01mg/L	nd	nd	nd	nd	nd	nd	nd	nd	--	nd	nd	--
Chromium (Total)	0.01-0.05mg/L	nd	0.011	nd	0.011	nd	0.014	nd	0.015	--	nd	0.018	--
Copper	0.01-0.02mg/L	nd	0.051	nd	nd	nd	0.025	nd	nd	--	.018	nd	--
Iron	0.5-0.05mg/L	0.29	0.44	0.20	0.14	2.54	0.21	0.36	0.11	--	1.74	0.38	--
Lead	0.005-0.02	nd	nd	nd	nd	nd	nd	nd	nd	--	nd	nd	—
Nickel	0.04-0.1mg/L	nd	0.20	nd	0.22	nd	0.21	nd	0.26	--	nd	0.24	--
Mercury	0.0005-0.001mg/L	nd	nd	nd	nd	nd	nd	nd	nd	--	nd	nd	--
Selenium	0.005-0.01mg/L	nd	nd	nd	nd	nd	nd	nd	nd	--	nd	nd	--
Silver	0.0025-0.02mg/L	nd	nd	nd	nd	nd	nd	nd	nd	--	nd	nd	--
Zinc	0.01-.02mg/L	0.07	0.019	0.06	0.035	0.08	0.057	0.02	nd	--	0.06	0.21	--
Detected Priority Pollutant Volatile Compounds [1]													
Tetrachlorethylene	ug/L	nd	nd	nd	nd	nd	nd	5	[illegible]	nd	[illegible]	nd	nd

nd- none detected
1- Detection limit for VOCs as stated in EPA Methods 601 and 602
--- - Parameter not specified

WESTON

Table 4-17 (Cont.)
ANALYTICAL RESULTS - GROUNDWATER
ZONE 3

Parameter	Detection Limit & Reporting Unit	RFW-23 3/22/85	RFW-23 5/7/85	RFW-23 8/9/85	RFW-24 4/_/85	RFW-24 5/6/85	RFW-39 4/3/85	RFW-40 5/7/85
TOX	5 ug/L	11	14	--	nd	12	nd	6
TOC	0.5 mg/L	1.2	0.09	--	3.2	nd	0.5	0.6
Oil & Grease	0.1 mg/L	0.31	nd	--	2.25	0.47	3.47	0.3
Phenol	0.005 mg/L	0.014	nd	--	0.005	nd	0.007	0.006
Arsenic	0.01 mg/L	nd	nd	--	nd	0.01	nd	nd
Barium	0.01-0.02 mg/L	nd	0.04	--	0.04	0.05	0.04	0.09
Cadmium	0.003-0.01 mg/L	nd	nd	--	nd	nd	nd	nd
Chromium(Total)	0.01-0.05 mg/L	nd	0.012	--	nd	0.011	nd	nd
Copper	0.01-0.02 mg/L	nd	0.022	--	nd	nd	nd	0.03
Iron	0.5-0.05 mg/L	0.66	0.15	--	0.19	0.19	0.1	0.15
Lead	0.005-0.02 mg/L	nd	nd	--	nd	nd	nd	nd
Nickel	0.04-0.1 mg/L	nd	0.2	--	nd	0.21	nd	0.19
Mercury	0.0005-0.001 mg/L	nd	nd	--	nd	nd	nd	nd
Selenium	0.005-0.01 mg/L	nd	nd	--	nd	nd	nd	nd
Silver	0.0025-0.01 mg/L	nd	nd	--	nd	nd	nd	nd
Zinc	0.01-0.02 mg/L	nd	0.29	--	0.07	0.038	0.05	0.012
Detected Priority Pollutant Volatile Compounds (1)								
Trans-1,2-Dichloroethlyene		#	nd	3.6	nd	nd	nd	nd

(1)- Detection limits for VOC's as stated in EPA methods 601 and 602
\# - resampled due to quality control or lost sample
nd - none detected
RFW-39 is a duplicate of RFW-24; RFW-40 is a field blank

and were not encountered in RFW-18, RFW-19, and RFW-20; but reappear in RFW-24 farther to the west.

The sand and gravel deposits increase in thickness toward the west where the surficial deposits are described as a kame plain. In RFW-18 and RFW-20 they were 34 and 31 feet thick respectively. Shallow bedrock conditions are found in the southern portion of the site in the vicinity of RFW-22 and RFW-23 where sands and gravel overlie bedrock. Glacial till is found beneath the sands and gravels in RFW-18, RFW-19, RFW-20, RFW-21, and RFW-24. The thickness of the till layers varies from approximately 15 feet in RFW-21 to 40 feet in RFW-18.

The depth to bedrock in the IS/PA zone varied from approximately 4 feet at RFW-23 to greater than 74 feet at RFW-18. Bedrock outcrops are found near the base Hospital on Rockingham Drive. The available bedrock data indicates that a bedrock contact between the Eliot and Kittery Formations passes through the site. Drill cuttings and core samples reveal that the site is underlain by well foliated schists and slates with calcareous mineralization and quartz veins, characteristic of both formations. In general, the bedrock was found to be moderately to highly fractured in the upper five feet. A 15-gallon per minute or greater loss of water was noted during coring operations at RFW-24, which suggests that interconnected fractures were extensive.

The regional groundwater flow through Zone 1 is toward the south at a hydraulic gradient of approximately 0.006. However, numerous drainage channels and streams flow through the area and much of the shallow groundwater flow probably discharges to them. The regional flow patterns in the IS/PA are subject to small localized variations due to pumpage from the Haven, Smith, and Harrison production wells. The maximum safe yield of the three production wells is approximately 1500 gallons per minute with reported drawdown of 13.7 feet, 6 feet, and 15.5 feet respectively (Phase I Report, 1984). The pumping of the wells individually or in combination will likely effect the localized groundwater flow lines. However, a preliminary analysis of existing pump/drawdown data does not suggest widespread cones of depression.

During the drilling and installation of monitoring wells and piezometers in Zone 3, groundwater was encountered at depths ranging from 3 to 21.3 feet below ground surface. In gener-

al, the shallower water table conditions were found in the less permeable deposits in the eastern portion of the IS/PA (RFW-22 and RFW-23).

4.4.4.2 Tank Sampling Results - IS/PA

Tank TA-1 located adjacent to Building 244 and TA-2 adjacent to Building 113 (Figure 3-7) were reportedly used for the storage of waste trichloroethylene (TCE) generated by vapor degreasing operations formally housed in the two buildings. The tanks were, reportedly, abandoned in 1962. The two tanks were sampled on 24 April 1985 as described in Appendix F.1 and Subsection 3.2.6 above. Tank TA-1 at Building 244 contained three feet of liquid TA-2 at Building 113 was filled with sand. The sample from TA-1 was taken from standing liquid within the tank and analyzed for TOX, TOC, O&G and Priority Pollutant Volatile organic compounds (VOC). The analysis detected a TOX concentration of 8910 ug/l and levels of TCE and trans-1,2-dichloroethylene of 22,000 ug/l and 7,000 ug/l, respectively. The concentration of TOC and O&G were 10.2 and 8.68 mg/l, respectively.

Tank TA-2 had been filled with sand. Therefore, a saturated solid sample was taken and analyzed for the same parameters listed above. There were no detectable TOX, and the O&G concentration (10.0 mg/kg) was within the low range (Table 4-3). Low levels of trichloroethylene (12.0 mg/kg) and trans-1,2-dichloroethylene were also detected.

An HNu photoionization detector, used to screen the air in the breathing zone for detectable levels of volatile organic compounds, registered a reading of 200 ppm from an agitated sample of liquid taken from TA-1. An agitated soil sample from TA-2 registered a slight deflection (<1 ppm) of the meter.

4.4.4.3 Soil Sampling Results - IS/PA

Seventeen soil samples were collected from power auger borings at eight subsites in Zone 3. The statement of work specified analysis for TOX, TOC, phenol, priority pollutant metals, and VOC. The purpose of the sampling was to identify areas of possible contamination within the zone. Figure 3-7 shows the locations of the soil borings. Table 4-16 presents the analytical results by subsite.

IS/PA Subsite - Building 119

Boring 15-B-1 was installed adjacent to a paved parking area on the south side of Building 119 adjacent to a drum staging area where waste oils and solvents from the fuel maintenance squadron shop are stored. A soil sample collected from the boring on 20 November 1984 was found to contain 1,800 mg/kg of O&G. The other required analytes were inadvertently omitted from the analytical protocol. A second sample from the area was collected on 14 August 1985 and analyzed for the remaining parameters. The soil sample was black and oily in appearance. It contained elevated concentrations of TOX (67.5 mg/kg), phenols (4.37 mg/kg,) and VOC. Among the VOC present in the highest concentrations were chlorobenzene (4.0 mg/kg), chloroform (0.35 mg/kg), toluene (3.8 mg/kg), ethyl benzene (7.5 mg/kg), and total dichlorobenzene (66.0 mg/kg).

Boring 15-B-2 was installed south of 15-B-1, in a downgradient direction toward a stream which flows through the area. Analysis of a sample taken from a depth of eight to ten feet showed no detectable TOX. Concentrations of O&G were also at background levels. There were no detectable phenols, and the metals detected are all within the magnitude of concentrations typically found in soils (Table 4-4). There were no detectable volatile organic compounds in the sample.

IS/PA Subsite - Building 113

Borings 15-B-3, 15-B-4, 15-B-19, and 15-B-22 were installed in the vicinity of Building 113, the location of a former vapor degreasing operation (Figure 3-7). Boring 15-B-3 was drilled in a drainage swale across Dover Avenue and west of Building 113. Borings 15-B-4 and 15-B-19 were drilled approximately 50 feet north of Building 113 and the former waste TCE tank (TA-2). These locations are near a wetland between Buildings 113 and 119. Boring 15-B-22 was drilled beyond a parking lot east of Building 113.

The analytical results are presented on Table 4-16. Samples 15-B-3 and 15-B-22 did not reveal the presence of VOC. Metal parameters were generally within anticipated background ranges. Phenols were not detected in these samples. Oil and grease results for 15-B-3 and 15-B-22 were within background (Table 4-3). A TOX concentration of 0.3 mg/kg was detected in 15-B-22. Although this concentration is considered to be a low concentration, no priority pollutants

were detected. Therefore, no adverse impacts were noted from the analyses of these two samples.

Analytical results from 15-B-4 and 15-B-19 do show evidence of environmental impact. Based on the screening protocols of TOX and O&G, low concentrations of these analytes were detected. TOX in 15-B-19 was 0.2 mg/kg; O&G were 947 mg/kg in 15-B-4 and 601 mg/kg in 15-B-19. They are also at least one order of magnitude higher than the O&G results from 15-B-3 and 15-B-22. Both samples contained VOC. Sample 15-B-4 contained 0.21 mg/kg TCE and 0.57 mg/kg xylene. Sample 15-B-19 had 0.079 mg/kg TCE, 0.044 mg/kg methylene chloride, and 0.012 mg/kg tetrachloroethylene. Total VOC concentrations were less than one mg/kg (parts per million). Phenols and metals were within anticipated background concentrations.

In summary, several priority pollutant organics were noted in low concentrations in soils near Tank TA-2 and Building 113. Tank sample results (Table 4-15) reveal that the only common priority pollutant common to the soil and tank fluid results is TCE.

IS/PA Subsite - Building 226

Samples 15-B-5, 15-B-6 and 15-B-7 were taken from borings south and east of Building 226 where 55-gallon drums of waste organic compounds currently are stored. TOX levels ranged between 0.2 to 0.6 mg/kg and oil and grease levels ranged from 21 to 1290 mg/kg. Phenol concentrations ranged from 0.135 to 0.222 mg/kg, with the exception of zinc, metals analyses were all within expected natural ranges (Table 4-4). Zinc concentration in the soils from these and several other borings in the IS/PA are higher than the cited literature for natural zinc concentrations in soils (Table 4-4).

The only volatile organic compound detected in any of the samples was 0.004 ug/kg of methylene chloride in 15-B-6. Methylene chloride is a common laboratory artifact. Furthermore, it was detected in five of the six samples collected on 9-10 April 1985. An HNu reading of 60 ppm was recorded in borehole 15-B-5 at eight feet. However, the analytical results do not support the field test result. No probable explanation for this is available with the existing information.

IS/PA Subsite - Building 244

Borings 15-B-8 and 15-B-9 were installed in the vicinity of a former waste TCE tank on the south side of Building 244. The TOX levels of 0.3 mg/kg in 15-B-8 and 0.5 mg/kg in 15-B-9 were typical of the low ranges found throughout the IS/PA. There was no detectable oil and grease in 15-B-8 and only 24 mg/kg in 15-B-9. Phenol concentrations were 0.197 mg/kg in 15-B-8 and 0.150 mg/kg in 15-B-9. The metals concentrations were all within the typical background ranges cited in Table 4-4. Three Priority Pollutant VOC were detected in the two samples; TCE, chloroform, and methylene chloride were found in 15-B-9 at concentrations less than 0.005 mg/kg. Methylene chloride was detected in 15-B-8 (0.009 mg/kg). As discussed above, methylene chloride is commonly found as a laboratory artifact, as is chloroform, and the presence of these two compounds in samples from borings 15-B-8 and 15-B-9 are not concluded to be associated with the site. TCE was detected in concentrations of 0.01 mg/kg in 15-B-8 and 0.004 mg/kg in 15-B-9. The presence of TCE in two borings suggests that the abandoned underground tank may have historically leaked to the surrounding environment. Trichloroethylene was found in TA-1 adjacent to Building 244 in concentrations of 22 mg/kg.

IS/PA Subsite - Building 222

Borings 15-B-10 and 15-B-11 were installed in a low swale approximately 100 feet south of Building 222 (Figure 3-7), the Jet Engine Test cell. With the exception of VOC, all parameters detected at 15-B-10 were within background ranges, as discussed above; the presence of 0.016 mg/kg of methylene chloride and 0.085 mg/kg of dichlorodifluoromethane is probably due to laboratory contamination. The sample from 15-B-11, collected on 10 April 1985, contained 691 mg/kg O&G. The presence of hydrocarbons in the VOC sample interfered with the quantification of toluene and ethyl benzene according to the lab report (Appendix I). The VOC that were quantified were chloroform at 0.047 mg/kg and methylene chloride at 0.004 mg/kg. Field screening of the boreholes with an HNu produced a reading of 160 ppm in boring 15-B-11. Petroleum hydrocarbons are concluded to be present; however, the quantity is unknown.

IS/PA Subsite - Building 234

Borings 15-B-15 and 15-B-17 were installed at Building 234. This building is currently referred to as the Liquid Oxygen

Building. Pre-site reconnaissance with base personnel indicated this might have formerly been an area where hazardous substances were handled. Boring 15-B-15 was located adjacent to the parking area northwest of the building. Boring 15-B-17 was sited southwest of the building. The samples were analyzed for TOX, O&G, phenols, metals, and VOC. The TOX value of 0.3 mg/kg from 15-B-15 was concluded to be within the moderate range of values (Table 4-3) for that screening parameter. None of the other analytical protocols detected concentrations of analytes above expected background levels.

IS/PA Subsite - Building 120

Boring 15-B-18 was sited adjacent to the southeast corner of Building 120. The TOX and O&G concentrations of 1.4 mg/kg and 1,460 mg/kg, respectively, indicate the presence of some organic contaminants, however, no VOC were detected. The presence of 5.62 mg/kg phenol, 130 mg/kg chromium, and 160 mg/kg lead was also notably higher than elsewhere in the site and the zone. Zinc (65.5 mg/kg) was also found to be elevated when compared to other soil results and published literature (Table 4-4).

IS/PA Subsite - Building 229

Boring 15-B-24 was installed in a drainage swale approximately 50 feet west of Building 229. Oily discharges from a malfunctioning oil/water separator had reportedly discharged to this swale in the past. An HNu scan of the power auger hole detected up to 100 ppm of total volatile organic compounds. However, laboratory analyses detected no VOC in 15-B-24. Field personnel noted an organic chemical odor and the presence of black stained soil materials.

4.4.4.4 Groundwater Results - IS/PA

Seven groundwater monitoring wells at the IS/PA were sampled on two occasions. Sample RFW-39 was a duplicate sample from RFW-24 collected during the first round. A field blank designated RFW-40 was prepared during the second round of sampling. The first round VOC samples for RFW-21, RFW-22, and RFW-23 were not analyzed within the recommended holding time of 14 days and were, therefore, resampled on 9 August 1985.

Analysis for the screening parameters consisting of TOX, TOC and O&G were performed on groundwater samples from the seven wells in Zone 3 on two occasions. TOX values ranged from

"none detected" (<5 ug/l) to 27 ug/l (Table 4-5 and Table 4-17). Overall, the TOX results were within the anticipated background ranges and only two of fourteen TOX samples showed levels of this screening parameter.

The TOC results for all rounds of sampling were less than 18 mg/l and thus, were characterized as representative of background conditions (<20 mg/l). The O&G results exhibited no consistent pattern, either between wells or between sampling rounds (Table 4-5 and Table 4-17). Results ranged from "none detected" to 2.25 mg/l (RFW-24).

The combination of all screening protocol results from the zone are indicative of groundwaters that are largely unimpacted. This conclusion is based upon the interpretive ranges identified in Table 4-3.

Phenols were detected in the first round samples from RFW-19, RFW-22 and RFW-24, and in a second round sample from RFW-24. Wells RFW-22 and RFW-23 each exhibited 0.014 mg/l phenol in the first round (March 1985) samples. These were the most elevated concentrations monitored in Zone 3. No phenols were detected in the second round (May 1985) samples from RFW-22 and RFW-23. The field blank RFW-40, prepared during the second round of sampling, contained 0.006 mg/l phenol. All other phenol results were within 0.002 mg/l of this value. Significant concentrations of phenolics attributable to a source of contamination were not detected in Zone 3.

No significant concentrations of metals were detected in two sampling rounds. Total dissolved iron concentrations ranged between 0.14 and 2.54 mg/l for both sampling rounds. Wells RFW-20 and RFW-22 exhibited total dissolved iron concentrations of 2.54 to 1.74 mg/l, respectively, during the first round of sampling. These concentrations dropped to 0.21 to 0.38 mg/l during the second round of analyses. Nickel was detected in all second round samples within the same concentration range as field blank RFW-40. Zinc was detected well within the state or Federal MCL of 5 mg/l.

Volatile organic compounds were found in RFW-21, and RFW-23 in concentrations less than five ug/l. No well exhibited more than one priority pollutant volatile organic (Table 4-17). No individual compound was detected in both sampling rounds at a given well. Trichloroethylene, formerly a principal contaminant in the base groundwater supply, was not detected in any of the seven monitoring wells in Zone 3.

4.4.4.5 Contamination Profile - IS/PA

Evidence of soil contamination was detected in six subsites generally associated with active or former shops where hazardous materials may have been handled. Volatile organic compounds in soils were detected at four of these subsites (Buildings 113, 119, 222 and 244).

Below ground waste storage tanks at Buildings 113 and 244 each were sampled in conjunction with soil sampling near each tank. At Building 113, priority pollutant volatile organic compounds below 1.0 mg/kg were detected in one soil sample. This sample was collected approximately 50 feet from Tank TA-2 indicating some potential contamination from the tank or operational area around Building 113.

Although Tank TA-2 at Building 113 reportedly had received waste solvents, only trace levels of volatile organic compounds were detected in the soils within the tank backfill.

Tank TA-1 at Building 244 contained liquid with total priority pollutant volatile compounds in excess of 29,000 ug/l. Soil samples 15-B-8 and 15-B-9 collected near Tank TA-1 both exhibited trace concentrations (<0.02 mg/kg) of priority pollutant volatile organics. Trichloroethylene, which was the principal VOC in TA-1, was detected in both soil samples.

Soils adjacent to Building 119 were highly contaminated with volatile organic compounds (greater than 70.0 mg/kg). Lateral migration of the contaminants appears to be limited since saturated soil samples taken from approximately 50 feet downgradient from the Building 119 parking area contained no detectable VOC.

Boring 15-B-5, near Building 226 produced a sample with high levels of O&G (1,290 mg/kg) and an in situ HNu reading of 60 ppm. Since the area is a storage facility for drums of waste organics, localized contamination may have occurred from spilled VOC. A reported gasoline spill near Building 222 has apparently contaminated the soil in this area (personal communications with flightline personnel 1985). The contaminants detected in 15-B-11 (Figure 3-7) included O&G in elevated concentrations (691 mg/kg) but did not extend to 15-B-10 located approximately 50 feet north of 15-B-11.

Boring 15-B-18 is located near the paint shop in Building 120. As discussed above, O&G, phenol, chromium, lead, and zinc were detected in concentrations either above anticipated background or in higher concentrations than other soils analyzed from the zone. It is possible that all these analytes are associated with waste paints and thinners reportedly used in the shop (Phase I Report, 1984). Black stained soil, petrochemical-like odors, and elevated HNu readings in the vicinity of boring 15-B-24, as well as, allegations of a faulty oil/water separator, indicate a potential contamination problem at Building 229 (Figure 3-7).

The soils analyses for the IS/PA show four subsites exhibiting confirmed contamination by volatile organic compounds. These subsites are Buildings 113, 119, 222 and 244. Only the soils near Building 119 could be characterized as substantially contaminated. These findings appear to be confirmed by the results of the seven monitoring wells installed in Zone 3. Priority pollutant metals were not detected in significant concentrations in any of the monitoring wells in Zone 3. Zinc, which was detected in soils, above anticipated natural background conditions, was not detected in significant concentrations in groundwater.

Only three of seven monitoring wells in the IS/PA exhibited the presence of Priority Pollutant Volatile Organics and only two volatile analytes were detected (Table 4-17). Three base production wells (Smith, Harrison, and Haven) are located within or immediately downgradient of the IS/PA. Levels of TOX above expected background concentrations (>15 ug/l) were found in all three wells and two VOC trichloroethylene and 1,2 trans-dichloroethylene were found in Haven well at relatively low levels (3.5 and 7.0 ug/l TCE and 2.0 ug/l 1,2-trans-dichloroethylene). The Haven well has historically contained elevated concentrations of TCE, the source of which has never been determined. TCE concentrations of as high as 391 ug/l were detected in 1977, but by 1982 the concentrations had decreased to an average of 8.7 ug/l. The relatively rapid flow velocities in the sand and gravel beneath the flightline is probably responsible for diluting and flushing contaminants from the aquifer.

Groundwater samples from three of the seven monitoring wells and three production wells within the IS/PA area show minor levels of Priority Pollutant VOC contamination, but do not indicate any potential major health hazard or gross contam-

ination problem. Four monitoring wells were free of VOC on both sampling rounds.

Groundwater flow in and around IS/PA is complex because of the varied geologic conditions. In the southeastern part of the IS/PA, the unconsolidated deposits are relatively thin (<10 feet) and the bedrock probably controls groundwater flow. To the southwest, kame deposits become thicker (up to 74 feet). In these areas, groundwater occurs in both the surficial kame deposits and the deeper fractured bedrock.

The current data is insufficient to determine if the flow in these formations differs in magnitude or direction. In addition, the nature and extent of bedrock fracturing is unknown. During drilling, extensive fracturing and large water loss was noted in the bedrock at RFW-24. Conversely, RFW-23, in the southwest part of the site, produced little water and was pumped dry using a hand bailer. With the current data, it is not possible to determine the direction of flow and potential contaminant migration in the bedrock. RFW-23 does not tap a water-bearing fracture and probably is not indicative of the groundwater in the area. However, RFW-2 does intercept a major fracture system that exists west of the site.

4.4.5 Zone 4, Drainage Ditches - Sites 19, 20, 21, and Active Production Wells

Six surface water sampling locations and six stream sediment sample locations were designated along Grafton and Newfields Ditches and McIntyre Brook (Figures 3-14, 3-15, 3-16). Two rounds of surface water samples and a single round of sediment samples were collected. A set of duplicate sediment samples, SD-3 and SD-4, were also collected for QA/QC purposes. The analytical results are listed in Tables 4-18, 4-19, and 4-20. In the first round, surface water O&G samples were not analyzed within the recommended holding time, and, therefore, were resampled in August 1985.

Pease AFB drinking water is supplied by six active production wells on the base (Figure 1-9). The six wells were sampled on two occasions and analyzed for TOX, TOC, O&G Priority Pollutant metals, and VOC. The first round of oil and grease samples and both rounds of VOC samples were not analyzed within the recommended holding times, and, therefore, were resampled. Analytical results for the wells are presented in Table 4-21.

TABLE 4-18

ANALYTICAL RESULTS
ZONE 4
MCINTYRE BROOK

Parameter	Detection Limit and Reporting Unit: Water	Detection Limit and Reporting Unit: Soil	Surface Waters: SW-19 11/18/84	SW-19 3/13/85	SW-19 8/8/85	SW-20 11/8/84	SW-20 3/13/85	SW-20 8/8/85	Sediments: SD-1 11/8/84	SD-1 8/8/85	SD-2 11/8/84	SD-2 8/8/85
TOX	5.0 ug/l	0.1 - 5.0 mg/kg	22	23	—	19	24	—	0.1	—	ND	—
TOC	0.5 mg/l		2.70	8.0	—	2.70	8.40	—	—	—	—	—
Oil & Grease	0.1 mg/l	5.0 - 7.0 mg/kg	#	0.23	0.28	#	0.73	0.31	130	—	180	—
Arsenic	0.01 mg/l	0.5 - 1.25 mg/kg	ND	ND	—	ND	ND	—	#	31	#	50
Barium	0.01 - 0.02 mg/l	1.0 - 2.0 mg/kg	ND	ND	—	ND	ND	—	#	79	#	99
Cadmium	0.003 - 0.01 mg/l	0.13 - 5.0 mg/kg	ND	ND	—	ND	0.006	—	#	10	#	12
Chromium-Total	0.01 - 0.05 mg/l	1.25 - 5.0 mg/kg	ND	ND	—	ND	ND	—	#	45	#	50
Copper	0.01 - 0.02 mg/l	1.0 - 3.0 mg/kg	ND	ND	—	ND	0.068	—	#	28	#	30
Iron	0.5 - 0.5 mg/l	5.0 - 250.0 mg/kg	0.68	0.86	—	0.66	2.17	—	#	40,000	#	46,000
Lead	0.005 - 0.02 mg/l	5.0 mg/kg	ND	ND	—	ND	0.016	—	#	72	#	86
Nickel	0.04 - 0.1 mg/l	2.5 - 10.0 mg/kg	ND	ND	—	ND	ND	—	#	35	#	40
Mercury	0.0005 - 0.25 mg/l	0.1 - 0.25 mg/kg	ND	ND	—	ND	ND	—	#	0.25	#	0.26
Selenium	0.005 - 0.01 mg/l	0.5 mg/kg	ND	ND	—	ND	ND	—	#	ND	#	ND
Silver	0.0026 - 0.01 mg/l	0.13 -2.5 mg/kg	ND	ND	—	ND	ND	—	#	ND	#	ND
Zinc	0.01 - 0.02 mg/l	0.5 mg/kg	0.02	ND	—	ND	0.02	—	#	92	#	120

ND - None Detected.

\# - Resampled due to quality control or lost sample.

— - Parameter not specified.

TABLE 4-19

ANALYTICAL RESULTS
ZONE 4
GRAFTON DITCH

		Surface Waters						
	Detection Limit and Reporting Unit	SW-21		SW-22			SW-23	
Parameter	Water	11/9/84	3/12/85	11/9/84	3/12/85	8/8/85	11/9/84	8/7/85
TOX	5.0 mg/l	31	23	34	20	—	#	--
TOC	0.5 mg/l	9.30	6.70	3.4	6.7	—	ND	--
Oil & Grease	0.1 mg/l	0.10	0.17	#	2.5	0.26	#	0.12
Arsenic	0.01 mg/l	ND	ND	ND	ND	—	#	ND
Barium	0.01 - 0.02 mg/l	ND	ND	ND	ND	—	#	ND
Cadmium	0.003 - 0.01 mg/l	ND	ND	ND	0.004	—	#	ND
Chromium-Total	0.01 - 0.05 mg/l	ND	ND	ND	ND	—	#	ND
Copper	0.01 - 0.02 mg/l	9.49	0.01	ND	0.022	—	#	ND
Iron	0.5 - 0.5 mg/l	0.05	0.76	0.52	1.92	—	#	.37
Lead	0.005 - 0.02 mg/l	0.05	ND	ND	0.037	—	#	ND
Nickel	0.04 - 0.1 mg/l	ND	ND	ND	ND	—	#	ND
Mercury	0.0005 - 0.25 mg/l	ND	ND	ND	ND	—	#	ND
Selenium	0.005 - 0.01 mg/l	ND	ND	ND	ND	—	#	ND
Silver	0.0026 - 0.01 mg/l	ND	ND	ND	ND	—	#	ND
Zinc	0.01 - 0.02 mg/l	0.02	ND	ND	0.02	—	#	ND

ND - None Detected.

- Resampled due to quality control or lost sample.

— - Parameter not specified.

SD-4 is a duplicate of SD-3.

SW-23 is a duplicate of SW-22.

Table 4-19 (Cont.)

ANALYTICAL RESULTS
ZONE 4
GRAFTON DITCH

Parameter	Detection Limit and Reporting Unit: Soil	Sediments: SD-3 11/9/84	Sediments: SD-3 8/7/85	Sediments: SD-4 11/8/84	Sediments: SD-4 8/7/85	Sediments: SD-5 11/8/85	Sediments: SD-5 8/7/85
TOX	0.1 - 5.0 mg/kg	0.1	—	ND	—	1.6	—
Oil & Grease	5.0 - 7.0 mg/kg	84	—	88	—	3200	—
Arsenic	0.5 - 1.25 mg/kg	#	31.5	#	29.3	#	14.2
Barium	1.0 - 2.0 mg/kg	#	55.3	#	54.9	#	237.0
Cadmium	0.13 - 5.0 mg/kg	#	31.9	#	7.3	#	6.6
Chromium-Total	1.25 - 5.0 mg/kg	#	31.9	#	30.4	#	49.0
Copper	1.0 - 3.0 mg/kg	#	12.9	#	12.4	#	25.2
Iron	5.0 -250.0 mg/kg	#	22200	#	22,300	#	13,100.0
Lead	5.0 mg/kg	#	75.7	#	60.0	#	330.0
Nickel	2.5 - 10.0 mg/kg	#	20.3	#	21.0	#	18.5
Mercury	0.1 - 0.25 mg/kg	#	ND	#	ND	#	0.1
Selenium	0.5 mg/kg	#	ND	#	ND	#	ND
Silver	0.13 -2.5 mg/kg	#	ND	#	ND	#	ND
Zinc	0.5 mg/kg	#	59.6	#	64.1	#	177.0

ND - None Detected.

- Resampled due to quality control or lost sample.

— - Parameter not specified.

SD-4 is a duplicate of SD-3.

TABLE 4-20

ANALYTICAL RESULTS
ZONE 4
NEWFIELDS DITCH

Parameter	Detection Limit & Reporting Unit: Water	Detection Limit & Reporting Unit: Soil	SURFACE WATERS: SW-30 11/8/84	SW-30 3/12/85	SW-30 12/18/85	SW-31 11/8/84	SW-31 3/11/85	SW-31 8/7/85	SEDIMENTS: SD-6 11/8/84	SD-6 8/7/85	SD-7 11/8/84	SD-7 8/7/85
TOX	5 ug/L	0.1 mg/kg	127	28	--	38	22	--	0.8	--	ND	--
TOC	0.5 mg/L		#	8.5	13.8	5.0	6.4	--	--	--	--	--
Oil and Grease	0.1 mg/L	5-7 mg/kg	0.30	1.79	--	#	0.11	0.13	2200	--	93	--
Arsenic	0.01 mg/L	0.5-1.25 mg/kg	ND	ND	--	ND	ND	--	--	7.2	25.9	--
Barium	0.01-0.02 mg/L	1-2 mg/kg	ND	ND	--	ND	ND	--	--	28.3	69.4	25.9
Cadmium	0.003-0.01 mg/L	0.13-5 mg/kg	ND	0.009	--	ND	0.002	--	--	4.9	9.34	--
Chromium (Total)	0.01-0.05 mg/L	1.25-5 mg/kg	ND	ND	--	ND	ND	--	--	42.4	49.1	--
Copper	0.01-0.02 mg/L	1-3 mg/kg	ND	0.125	--	ND	0.05	--	--	25.1	25.1	--
Iron	0.5 - 0.05 mg/L	5-250 mg/kg	0.32	4.97	--	0.30	1.78	--	--	8190	20500	--
Lead	0.005-0.02 mg/L	5 mg/kg	ND	0.045	--	0.026	ND	--	--	271.0	268	--
Nickel	0.04-0.1 mg/L	2.5-10 mg/kg	ND	ND	--	ND	ND	--	--	15.0	32.8	--
Mercury	0.005-0.001 mg/L	0.1-0.25 mg/kg	ND	ND	--	ND	ND	--	--	ND	ND	--
Selenium	0.005-0.01 mg/L	0.5 mkg/kg	ND	ND	--	ND	ND	--	--	ND	ND	--
Silver	0.0025-0.01 mg/L	0.13-2.5 mg/kg	ND	ND	--	ND	ND	--	--	ND	ND	--
Zinc	0.01-0.02 mg/L	0.5 mg/kg	ND	0.07	--	ND	0.03	--	--	90.5	367	--

ND None Detected
Resampled due to quality control or lost sample
-- Parameter not specific

Table 4-21
ANALYTICAL RESULTS - GROUNDWATER

Zone 4

Production Wells

Parameter	Detection Limit & Reporting Unit	Smith Well PW-1				Harrison Well PW-2	
		11/7/84	3/13/85	8/7/85	9/5/85	11/7/84	3/13/85
TOX	5ug/L	21	27	--	--	8	110
TOC	0.5mg/L	0.5	0.7	--	--	1.2	1.6
Oil & Grease	0.1mg/L	#	nd	--	nd	(2)	0.15
Arsenic	0.01mg/L	nd	nd	--	--	nd	nd
Barium	0.01-0.02mg/L	nd	nd	--	--	nd	nd
Cadmium	0.003-0.01mg/L	nd	nd	--	--	nd	nd
Chromium(total)	0.01-0.05mg/L	nd	nd	--	--	nd	nd
Copper	0.01-0.02mg/L	nd	0.022	--	--	nd	0.034
Iron	0.5-0.05mg/L	0.08	nd	--	--	0.18	nd
Lead	0.005-0.02	nd	nd	--	--	nd	0.014
Nickel	0.04-0.1mg/L	nd	nd	--	--	nd	nd
Mercury	0.0005-0.001mg/L	nd	nd	--	--	nd	nd
Selenium	0.005-0.01mg/L	nd	nd	--	--	nd	nd
Silver	0.0025-0.02mg/L	nd	nd	--	--	nd	nd
Zinc	0.01-.02mg/L	nd	nd	--	--	nd	nd
Detected Priority Pollutant Volatile Compound (1)		#	#	nd	nd	#	#

(1) Detection limits for VOC's are as stated in EPA methods 601 and 602.
(2) Unable to resample PW-2 due to new pump configuration.
- Resampled due to quality control or lost samples.
nd - None Detected

Table 4-21 (Cont.)
ANALYTICAL RESULTS - GROUNDWATER
Zone 4

Production Wells

Parameter	Detection Limit & Reporting Unit	Haven Well PW-3				MMS-1 Well PW-4			
		11/7/84	3/13/85	8/7/85	9/5/85	11/7/84	3/13/85	8/7/85	9/5/85
TOX	5 ug/L	31	80	--	--	16	33	--	--
TOC	0.5 mg/L	0.5	nd	--	--	46.9	0.9	--	--
Oil & Grease	0.1 mg/L	#	nd	--	nd	#	nd	--	nd
Arsenic	0.01 mg/L	nd	nd	--	--	nd	nd	--	--
Barium	0.01-0.02 mg/L	nd	nd	--	--	nd	nd	--	--
Cadmium	0.003-0.01 mg/L	nd	nd	--	--	nd	nd	--	--
Chromium(total)	0.01-0.05 mg/L	nd	nd	--	--	nd	nd	--	--
Copper	0.01-0.02 mg/L	nd	0.07	--	--	nd	0.014	--	--
Iron	0.5-0.02 mg/L	0.06	nd	--	--	0.04	nd	--	--
Lead	0.005-0.02 mg/L	nd	nd	--	--	nd	nd	--	--
Nickel	0.04-0.1 mg/L	nd	nd	--	--	nd	nd	--	--
Mercury	0.0005-0.001 mg/L	nd	0.002	--	--	nd	nd	--	--
Selenium	0.005-0.01 mg/L	nd	nd	--	--	nd	nd	--	--
Silver	0.0025-0.01 mg/L	nd	nd	--	--	nd	nd	--	--
Zinc	0.01-0.02 mg/l	nd	nd	--	--	nd	nd	--	--
Detected Priority Pollutant Volatile Compound 1									
Trichloroethylene	ug/L	#	#	3.5	7.0	#	#	nd	nd
Trans-1,2-Dichloroethylene	ug/L	#	#	nd	2.0	#	#	nd	nd

(1) -Detection limits for VOC's are as stated in EPA methods 601 and 602.
\# -Resampled due to quality control or lost samples

nd -None detected.
-- -Parameter not specified.

Table 4-21 (Cont.)
ANALYTICAL RESULTS - GROUNDWATER

ZONE 4
PRODUCTION WELLS

Parameter	Detection Limit & Reporting Unit	MHS-2 Well PW-5 11/7/84	3/13/85	8/7/85	9/5/85	Loomis Well PW-6 11/7/84	3/13/85	8/7/85	9/5/85	Loomis Well PW-7 11/7/84	8/7/85
TOX	5 ug/L	6	18	--	--	10	62	--	--	22	--
TOC	0.5 mg/L	0.5	nd	--	--	0.8	0.6	--	--	nd	--
Oil & Grease	0.1 mg/L	#	0.2	--	nd	#	0.45	--	0.100	#	--
Arsenic	0.01 mg/L	nd	nd	--	--	0.012	nd	--	--	nd	--
Barium	0.01-0.02 mg/L	nd	nd	--	--	nd	nd	--	--	nd	--
Cadmium	0.003-0.01 mg/L	nd	nd	--	--	nd	nd	--	--	nd	--
Chromium(total)	0.01-0.05 mg/L	nd	nd	--	--	nd	nd	--	--	nd	--
Copper	0.01-0.02 mg/L	nd	nd	--	--	nd	0.012	--	--	nd	--
Iron	0.5-0.02 mg/L	0.11	nd	--	--	0.27	nd	--	--	0.11	--
Lead	0.005-0.02 mg/L	0.054	nd	--	--	nd	nd	--	--	nd	-
Nickel	0.04-0.1 mg/L	nd	nd	--	--	nd	nd	--	--	nd	--
Mercury	0.0005-0.001 mg/L	nd	nd	--	--	nd	0.001	--	--	nd	--
Selenium	0.005-0.01 mg/L	0.021	nd	--	--	nd	nd	--	--	nd	--
Silver	0.0025-0.01 mg/L	nd	nd	--	--	nd	nd	--	--	nd	--
Zinc	0.01-0.02 mg/l	0.06	nd	--	--	0.068	0.22	--	--	.038	--
Detected Priority Pollutant Volatile Compound 1											
Trichloroethylene	ug/L	#	#	nd	2.6	#	#	4.8	nd	#	nd
Dichlorobromomethane ug/L	ug/L	#	#	nd	nd	#	#	2.8	nd	#	nd
Chloroform	ug/L	#	#	nd	10.0	#	#	2.0	nd	#	nd
Methylene Chloride	ug/L	#	#	nd	15.3	#	#	nd	nd	#	nd
Toluene		#	#	nd	2.0	#	#	nd	nd	#	nd

1-Detection limits for VOC's are as stated in EPA methods 601 and 602
#-Resampled due to quality control or lost samples
nd-None detected
-- -Parameter not specified.
PW-7 is a duplicate from PW-6.

Site-specific hydrogeologic conditions are not presented in this section because subsurface investigations were not made for the drainage ditches or the active production wells.

4.4.5.1 Surface Water Results - Zone 4, Drainage Ditches

Samples SW-19 and SW-20 were collected from McIntyre Brook (also called Receiver Site Brook) near the Receiver Site. Both samples were anlayzed for TOX, TOC, O&G, and metals. The Phase I Report (1984), describes the Receiver Site as the "major discharge point" in the storm drainage system. An oil/water separator was installed at the site. Sample SW-19 was collected immediately downstream of the discharge channel from the separator; SW-20 was collected approximately 300 feet further downstream (Figure 3-14). The analytical results from the two rounds of sampling showed low (background) concentrations of TOX (19-24 9g/l). No evidence of contamination by hazardous substances was found (Table 4-18).

Two rounds of surface water samples were collected from Grafton Ditch (Figure 3-15) at SW-21 and SW-22 and analyzed for TOX, TOC and O&G, and metals. SW-23 was designated as a duplicate sampling point for SW-21 for selected parameters on each sampling round (Tables 4-5 and 4-19). The TOX concentrations in SW-21 and SW-22 ranged from 20 to 34 ug/l for both sampling rounds. A single sample from SW-22 contained 2.5 mg/l of O&G. The concentrations of TOX and O&G found in surface water grab samples from Grafton ditch are not considered to represent contamination problem from past practices.

The first round metals analysis from SW-21 contained 9.49 mg/l of copper. This concentration is an order of magnitude above the State MCL of 1 mg/l. A second sample from SW-21 contained only 0.01 mg/l of copper.

Two rounds of samples were collected from sampling points SW-30 and SW-31 located on Newfields Ditch (Figure 3-16). The first round TOC sample from SW-30 was lost and was resampled in December of 1985. A first round sample from SW-30 contained 127 ug/l of TOX. The second round sample contained 28 ug/l TOX. A second round sample from SW-30 contained 1.79 mg/l O&G. The first round sample contained 0.30 ug/l O&G. The second round sample from SW-30 contained concentrations of cadmium (0.85 mg/l), chromium (17.7 mg/l), and Iron (4.92 mg/l) in excess of the state MCL. The concentrations of all analytes in both rounds of samples from

SW-31 were within background ranges for surface waters found elsewhere at Pease AFB.

4.4.5.2 Sediment Sample Results - Zone 4, Drainage Dithces

Sediment samples SD-5 (Grafton Ditch) and SD-6 (Newfields Ditch) (Figures 3-15 and 3-16) contained TOX at 1.6 and 0.8 mg/kg, respectively. These concentrations are an order of magnitude higher than those found elsewhere in base sediment. Oil and grease levels in the same samples were also notably higher than in other samples. In both locations, an oily sheen was noticed on the surface water as the sample was being taken and at the sampling location for SD-5 an organic odor was also noted.

An examination of the results of metals in sediment from the three drainage ditches indicates some apparent effects from former site operations. Ditch sampling locations are illustrated in Figures 3-14 through 3-16. Sediment from McIntyre Brook (Table 4-18) indicates metal concentrations typical for the upper limits of cadmium, iron, and mercury naturally occurring in soil (Table 4-4). Zinc concentrations of 92 and 120 mg/kg are elevated with respect to published literature but are within the same order of magnitude as found in several soil samples from Zone 3 and results from Grafton and Newfields Ditches.

Sediment samples from Grafton and Newfields Ditches exhibited similar concentrations of metals. In Grafton Ditch, for example, cadmium and zinc were generally elevated when compared to published literature for soils. Newfields Ditch (Table 4-20) exhibited comparatively elevated concentrations of lead and zinc in the sediments. No analytical results of sediments exceeded a regulated criterion. The analytical results did suggest impacts from former site use.

4.4.5.3 Contamination Profile - Zone 4, Drainage Ditches

Surface water quality in the drainage ditches which receive discharge from the storm drains, was typical of natural surface water and with the exception of single cadmium and copper analyses, met state drinking water standards.

Concentrations of contaminants, particularly TOX, in the sediments associated with the drainage ditches suggest that halogenated organic compounds have been introduced to the surface drainage system. Historically, fuel spills and

disposal of solvents have resulted in their discharge to the storm drainage system. TOX and O&G levels in Grafton and Newfields Ditches reflect the fact that some of these wastes are retained in the sediments or possibly are still occasionally being discharged. Heavy metals analyses further support this assumption. The presence of lead in at least three samples from Grafton and Newfields Ditches may have resulted from leaded fuels. The lead concentration in SD-7 may be attributable to runoff from the Spaulding Turnpike (off-base) which parallels the ditch approximately 100 feet east from where the sample was taken. Cadmium and arsenic, found in oils, pesticides, and paints, were detected in several sediment samples.

Heavy metals are only slightly soluble in water and tend to adhere to soil particles. This is one reason why the metals are so much higher in the sediments than in the surface water samples. The quality of surface water exiting the base does not appear to pose a risk to human health or the environment. Furthermore, as noted in the Phase I report, current spill control procedures appear satisfactory to prevent future incidents.

4.4.5.4 Groundwater Results - Active Production Wells

Two rounds of samples were collected from each of the six active production wells. Additionally, a duplicate sample, PW-7 was collected from the Loomis Well during the first sampling round. Low concentrations of TOX were detected in PW-1 (Smith) and PW-3 (Haven) during the first round of sampling (Table 4-21). During the second sampling round TOX levels were low to elevated in all wells except for PW-5 (MMS-2), ranging from 27 ug/l in PW-1 to 110 ug/l in PW-2 (Harrison). Six volatile organic compounds were detected in the three base production wells in two rounds of sampling (Table 4-21). Well PW-3 has historically shown contamination by trichloroethylene and contained 3.5 and 7.0 ug/l of TCE in two sampling rounds. Well PW-5 contained 29.9 ug/l of total volatile organic constituents when sampled on 5 September 1985. However, 25.3 ug/l of the 29.9 ug/l total were identified as chloroform and methylene chloride both common laboratory artifacts. Furthermore, the analysis of a previous sample from PW-5 contained no detectable volatile compounds. Well PW-6 (Loomis Well) contained three volatile compounds in a first round sampling (Table 4-21), a duplicate sample collected the same day contained no detectable volatile organic compounds. A second round sample collected on 5 September 1985 was also free of

volatile organic contamination, and it is concluded that water quality constituents in PW-6 probably do not represent a health hazard.

The base production well system has, in the past experienced contamination by the chlorinated solvent trichloroethylene (TCE). Concentrations as high as 391 ug/l were detected in Haven Well in 1977 (Bradley, 1982). Low levels of TCE and trans-1,2-dichloroethylene were found in Haven and MMS-2 wells during IRP sampling but at levels well below the state and federal lifetime SNARL of 75 ug/l. As discussed in previous subsections, TCE has been found in soil samples from borings in the vicinity of PW-3 (Haven well) and a sample from tank TA-1 contained high levels of both TCE and trans-1,2-dichloroethylene. Tank TA-1 has historically been considered a potential source of the contamination in Haven Well. The MMS-2 Well contained four volatile organic compounds in the second round resample; however, none of the concentrations exceeded existing SNARL. No volatile organic compounds were detected in the first round resample.

4.4.6 Munitions Storage Area (MSA) - Site 12

Power auger holes were drilled at four locations in the MSA and soil samples were collected at three of the locations (Figure 3-9). Two surface water samples were also collected as part of the sampling program at this site (Figure 3-9). Additionally, surface water sample SW-16, discussed in Subsection 4.4.3.3 was collected from an unnamed tributary to the Bass Pond. The tributary receives runoff from the eastern portion of the MSA. The analytical results are presented in Tables 4-22 and 4-23.

4.4.6.1 Hydrogeologic Conditions - MSA

Three power auger borings were installed west of Building 466 along the edge of the paved parking area to assess the stratigraphy and to collect samples for laboratory analysis. The nature of the material directly underlying the site is fine to coarse sand and gravel and is probably fill material. An abundance of cobbles limited the depth of penetration of the borings to three feet in Borings 12-B-1 and 12-B-2, and to nine feet in Boring 12-B-3. Regional groundwater beneath the site flows from east to west discharging to two unnamed streams and Great Bay on the west (Figure 4-5), while some local flow discharges to Stubbs Pond (also called the Bass Pond) via a small, unnamed tributary, to the east (Figure 1-11). Pumpage from the two

TABLE 4-22

ANALYTICAL RESULTS - SOIL
MSA

Parameter	Detection Limit and Reporting Unit	12-B-1 12/28/84	12-B-2 12/28/84	12-B-3 12/28/84
TOX	0.1-5.0 mg/kg	0.7	0.1	ND
O & G	5-7 mg/kg	217	149	37

ND = None detected

TABLE 4-23

ANALYTICAL RESULTS - SURFACE WATERS

MSA

Parameter	Detection Limit and Reporting Unit	SW-17			SW-18		
		11/7/84	3/13/85	8/8/85	11/7/84	3/13/85	8/8/85
TOX	5 ug/L	44	0.23	--	11	24	—
TOC	0.5 mg/L	2.3	5.6	--	1.8	8.4	—
Oil & Grease	0.1 mg/L	#	N.D.	11.3	#	N.D.	3.12

Notes:

N.D. - None detected

- Resampled due to quality control or lost sample

-- - Parameter not specified.

production wells MMS-1 and MMS-2 may produce some temporary, localized anomalies in the regional groundwater flow pattern. Saturated conditions were encountered in boring 12-B-3 at approximately eight feet below ground sursface. No data was available on the depth to and nature of the underlying bedrock.

4.4.6.2 Soil Sampling Results - MSA

Three soil samples were taken from shallow borings behind Building 466 in an area where small quantities of waste solvents and paint thinners were reported to have been dumped. TOX concentrations ranged from none detected to 0.7 mg/kg. In samples, 12-B-1 and 12-B-2 O&G results were low (217 and 149 mg/kg, respectively).

The areas of stained soil and vegetative stress were limited in size (1-2 feet in diameter), and no readings above background level were recorded on an HNu photoionization detector from power auger borings within each stained area.

4.4.6.3 Surface Water Results - MSA

Surface water samples from SW-17 and SW-18 contained TOX concentrations from 11 to 44 ug/l. These are considered to be background to low (Table 4-3). Oil and Grease concentrations of "none detected" to 11.3 mg/l were found during the two rounds of surface water sampling. No elevated TOC concentrations were detected in the surface water samples. In situ water quality parameters were measured (Table 3-6) and found to be within normal concentrations for natural waters.

4.4.6.4 Contamination Profile - MSA

The MSA is reported to have handled only small quantities of spent solvents and thinners, disposing of residual amounts along the margin of the paved area west of Building 466. Samples analyzed by the screening methodology (TOX, TOC and O&G), on site visual examination of soils, surface water sampling, and field screening of soil and air exhibited no evidence of significant contamination resulting from former waste handling practices.

4.4.7 Construction Rubble Dump No. 1 (CRD-1) - Site 9

Three surface water samples were collected on two occasions from Peverly Brook for the screening parameters, TOX and O&G. Peverly Brook flows from north to south approximately 400 feet west of the CRD-1 and discharges to Upper Peverly Pond (Figure 3-17). The Phase I report cites past disposal of waste solvents at the CRD-1.

All three locations (SW-10, SW-11, SW-12) were resampled for O&G when holding times were exceeded for the first round of samples. An additional TOX sample was also collected from SW-10 when the first round sample bottle was lost. A QA/QC field duplicate (SW-33) was collected with the second round of samples. The analytical results are presented in Table 4-24. Site-specific hydrogeologic conditions are not presented in this section because a subsurface investigation was not completed for the CRD-1.

4.4.7.1 Surface Water Results - CRD-1

The concentrations of TOX detected in the two rounds of sampling were characteristic of clean waters found elsewhere at Pease AFB, with the exception of the August 1985 sample from SW-10 (Table 4-24). The anomalously high concentration of 2630 ug/l for TOX in that sample was two to three orders of magnitude higher than any other sample from the area. The March 1985 TOX sample from SW-10 contained 35 ug/l. Oil and grease samples collected from SW-10 and SW-12 during the site resampling contained 2.41 and 6.24 mg/l, respectively. All other O&G samples contained concentrations of less than 0.58 mg/l. *In situ* specific conductance readings ranged from 250 to 700 umhos/cm on the three occasions that samples were collected. The value of 700 umhos/cm was recorded at SW-10 during the site resampling. *In situ* pH values were all within expected ranges for natural surface waters.

4.4.7.2 Contamination Profile - CRD-1

An inspection of the CRD-1 and surrounding area along Peverly Brook was made during each surface water sampling round. There was no evidence of stained soil, vegetative stress, or improper waste disposal practices.

A single sample from SW-10 which had presumably represented upgradient conditions contained 2630 ug/l TOX, 2.41 mg/l O&G, and an *in situ* value for specific conductance of 700 umhos/cm. A downstream sample collected on the same day at SW-12 contained 6.24 mg/l O&G. The other analytical re-

lABLE 4-24

ANALYTICAL RESULTS - SURFACE WATER

CRD 1

	SW-10			SW-11			SW-12			Field Duplicate SW-33
Parameter	11/7/84	3/11/85	8/6/85	11/7/84	3/11/85	8/6/85	11/7/84	3/11/85	8/6/85	3/11/85
TOX	#	35	2630	33	6.0		23	10		9
Oil & Grease	#	0.42	2.41	#	0.20	0.31	#	ND	6.24	0.58

Notes: Detection limits and Reporting Units

TOX - 5 ug/l.
Oil & Grease - 0.1 mg/l.
ND - None detected.
- Resampled due to quality control or lost samples.
— - Parameter not specified.
SW-33 is a field duplicate of SW-12.

sults from SW-10, SW-11 and SW-12 were within expected ranges of background concentrations (Table 4-2).

The analytical protocol for evaluating the CRD-1 was limited to TOX and O&G in surface waters. Groundwater samples which had been scheduled to be collected from abandoned wells in the area were not collected because the wells could not be located in the field.

The analytical results do not permit compound specific predictions to be made regarding the potential or real local environmental impacts of the CRD-1. The difficulty in assessing the results is compounded by the fact that SW-10, which was located to be hydraulically upgradient of the site, had elevated levels of TOX. Definitive conclusions based on the surface water data collected to date from this site cannot be made.

4.4.8 Zone 5, LF-6, Site 6 and Construction Rubble Dump No. 2 (CRD-2) - Site 17

A single groundwater monitoring well, RFW-32, was installed adjacent to and hydraulically downgradient of the CRD2. Three additional wells, RFW-33, RFW-34, and RFW-35, were spatially arranged to intercept groundwater flow from beneath LF-6. Six surface water locations (SW-24 through SW-29) were also selected for sampling (Figure 3-10). The analytical protocol for ground and surface waters was: TOX, TOC, O&G, phenols and metals. Results are illustrated on Table 4-25 and 4-26. Two rounds of samples were collected from each site. A duplicate sample was collected at SW-24 and labelled SW-34 during the second round of sampling. Oil and grease in the first sampling round from SW-25, SW-26, SW-27, SW-28, and SW-29 were not analyzed within the recommended holding time and were resampled on 7 August 1985. The TOX and metals samples were omitted from the sampling protocol for SW-25 in November 1984. These were collected in December 1985. A phenolic sample from SW-24 was also collected in December 1985.

4.4.8.1 Hydrogeologic Conditions - Zone 5, LF-6 and CRD-2

Four monitoring wells were installed in the vicinity of Landfill 6 and Construction Rubble Dump No. 2 (Figure 3-10). The well logs show the area to be underlain by bluish-green marine clays above till. The thickness of the clay varies from two feet in RFW-34 to ten feet in RFW-32. Glacial till was encountered below the clay in all four borings. The

Table 4-25

ANALYTICAL RESULTS - GROUNDWATER

Zone 5

PARAMETER	Detection Limit & Reporting Unit	CRD-2		LF-6					
		RFW-32		RFW-33		RFW-34		RFW-35	
		3/27/85	4/30/85	4/5/85	5/1/85	3/27/85	4/30/85	3/27/85	4/30/85
Water									
TOX	5ug/L	40	57	341	822	203	420	270	243
TOC	0.5mg/L	12.3	5.2	55.8	32.0	299	248	225	339
Oil & Grease	0.1mg/L	0.3	0.45	0.54	0.89	1.94	1.53	1.51	0.75
Phenol	0.005mg/L	0.01	nd	0.068	0.033	0.365	0.350	0.364	0.454
Arsenic	0.01.mg/L	nd	nd	nd	nd	0.108	0.016	0.026	nd
Barium	0.01-0.02mg/L	0.03	0.045	nd	nd	0.06	0.043	0.07	0.096
Cadmium	0.003-0.01mg/L	0.003	nd	nd	nd	nd	nd	nd	nd
Chromium	0.01-0.05mg/L	nd	0.019	nd	0.016	nd	0.02	nd	0.024
Copper	0.01-0.02mg/L	0.043	nd	nd	nd	nd	nd	0.011	nd
Iron	0.5-0.05mg/L	1.76	0.24	0.54	0.51	4.82	3.62	35.9	41.8
Lead	0.005-0.02mg/L	nd	nd	nd	nd	nd	nd	0.039	nd
Nickel	0.04-0.1mg/L	nd	nd	nd	0.32	nd	nd	nd	nd
Mercury	0.0005-0.001mg/L	nd	nd	nd	nd	nd	nd	nd	nd
Selenium	0.005-0.01mg/L	nd	nd	nd	nd	nd	nd	nd	nd
Silver	0.0025-0.01mg/L	nd	nd	nd	nd	nd	nd	nd	nd
Zinc	0.01-0.02mg/L	0.12	0.025	0.36	0.023	0.02	0.021	0.02	0.03

nd - none detected

TABLE 4-26

ANALYTICAL RESULTS - SURFACE WATER
ZONE 6
CFD 2 AND LF-6

PARAMETER		SW-24 11/9/84	SW-24 2/12/85	SW-25 11/9/84	SW-25 3/13/85	SW-25 8/7/85	SW-25 12/18/85	SW-26 11/9/84	SW-26 3/13/85	SW-26 8/7/85	SW-27 11/9/84	SW-27 3/13/85	SW-27 8/7/85
TOX	[illegible]	<1	[illegible]	●	<1	●	20.1	13	36	--	74	32	
TOC	0.5 mg/l	6.2	14.0	17.1	8.6			7.8	9.7	--	9.1	9.9	
Oil & Grease	0.005 mg/l	nd	0.12	●	1.09	nd	--	●	0.15	1.42	●	0.013	0.29
Phenol	0.005 mg/l	●	0.005	nd	nd			0.006	nd	--	0.005	nd	
Arsenic	0.01 mg/l	nd	nd	●	nd	●	nd	nd	nd	--	nd	nd	
Barium	0.03-0.02 mg/l	nd	nd	●	nd	●	nd	0.02	nd	-	nd	nd	
Cadmium	0.004-0.01 mg/l	nd	nd	●	0.002	●	nd	nd	nd	--	nd	nd	
Chromium	0.01-0.05 mg/l	nd	nd	●	nd	●	nd	nd	nd	--	nd	nd	
Copper	0.01-0.02 mg/l	nd	nd	●	0.064	●	nd	nd	0.056	--	0.04	nd	
Iron	0.5-0.05 mg/l	[illegible]	0.41	●	1.82	●	0.51	7.01	0.53	-	1.270	.32	
Lead	0.005-0.02 mg/l	nd	nd	●	nd	●	nd	0.041	nd	-	0.12	nd	
Nickel	0.04-0.1 mg/l	nd	nd	●	nd	●	nd	nd	nd	--	nd	nd	
Mercury	0.0005-0.001 mg/l	nd	nd	●	nd	●	nd	nd	nd	--	nd	nd	
Selenium	0.005-0.01 mg/l	nd	nd	●	nd	●	nd	nd	nd	--	nd	nd	
Silver	0.0025-0.02 mg/l	nd	nd	●	nd	●	nd	nd	nd	--	nd	nd	
Zinc	0.01-.02 mg/l	nd	nd	●	0.03	●	0.21	0.05	nd	--	0.03	nd	

● Resampled due to quality control or lost samples.
-- Parameter not specified.

Table 4-26 (Cont.)

ANALYTICAL RESULTS - SURFACE WATER
Zone 6
CRD 2 and SP-6

		SW-28			SW-29			SW-34 (1)
		11/9/84	3/13/85	8/7/85	11/9/84	3/13/85	8/7/85	3/12/85
TOX	**5ug/L**	74	35	--	62	25		23
TOC	**0.5mg/L**	15.4	8.6	--	14.9	13.0		1.1
Oil & Grease	**0.1mg/L**	#	0.75	0.74	#	0.19	0.97	nd
Phenol	**0.005mg/L**	0.006	nd	--	nd	nd	nd	nd
Arsenic	**0.01mg/L**	nd	nd	--	nd	nd	nd	nd
Barium	**0.01-0.02mg/L**	0.05	0.03	--	0.02	0.02		nd
Cadmium	**0.003-0.01mg/L**	nd	nd	--	nd	0.004		nd
Chromium	**0.01-0.05mg/L**	nd	nd	--	nd	nd		nd
Copper	**0.01-0.02mg/L**	0.047	0.05	--	0.41	0.064		nd
Iron	**0.5-0.05mg/L**	9.31	11.3	--	1.86	1.99		nd
Lead	**0.005-0.02**	0.05	0.015	--	0.021	nd		nd
Nickel	**0.04-0.1mg/L**	nd	nd	--	nd	0.001		nd
Mercury	**0.0005-0.001mg/L**	nd	nd	--	nd	nd		nd
Selenium	**0.005-0.01mg/L**	nd	nd	--	nd	nd		nd
Silver	**0.0025-0.02mg/L**	nd	nd	--	nd	nd		nd
Zinc	**0.01-.02mg/L**	0.01	0.02	--	0.06	0.03		nd

nd - None detected
* - Resampled due to quality control or lost sample.
-- - Parameter not specified.
(1) SW-34 is a duplicate of SW-24.

thickness of the gravelly till ranged from five feet in RFW-32 to 28 feet in RFW-35.

Drill cuttings and core samples were evaluated in the field and the bedrock was identified as gray slate of the Kittery Formation. Depths to bedrock range from 17 feet in RFW-32 to 41.5 feet in RFW-33.

Regional groundwater flow through this portion of the base is primarily toward the east at a relatively low gradient of 0.006. The presence of marine clays beneath the site and a probable upward hydraulic gradient in well RFW-32 indicate that the shallow flow system is recharged by the deeper flow system. The two sites within the zone occupy high points in the local topography which probably causes a certain amount of groundwater mounding and resultant radial flow. The semi-confining clay layer beneath the zone probably slows downward movement of groundwater; therefore, it is likely that the radial flow from the sites discharges to the wetland that virtually surround them.

4.4.8.2 Groundwater Results - Zone 5, LF-6 and CRD-2

RFW-32 is located adjacent to the CRD-2. TOX levels were 40 and 57 ug/l. All other analytical parameters were within anticipated background ranges for both sampling rounds. Specific conductance measurements were above background, suggesting localized impacts from fill materials.

Samples from RFW-33, RFW-34, RFW-35 and RFW-36 around LF-6 exhibited TOX concentrations ranging between 203 and 822 ug/l. For interpretive purposes, they were categorized in the elevated range (Table 4-3). These results were generally higher than other TOX results from the base (Table 4-5).

The TOC results for RFW-33 through RFW-35 were similarly concluded to be elevated and were found to be an order of magnitude higher than other base-wide TOC results (Table 4-5).

The third screening protocol, O&G, exhibited low concentrations in the three wells around LF-6. The O&G concentrations did not correlate with the TOC and TOX results in these wells.

Phenol concentrations exceeded the MCL of 0.001 mg/l by up to two orders of magnitude. These results were well within the EPA Water Quality Criteria for health of 3.5 mg/l. In

situ measurements of specific conductance in RFW-34 and RFW-35 varied from 1200 to 1400 umhos/cm as compared to base-wide results typically below 300 umhos/cm. Specific conductance results as high as 1,000 umhos/cm were monitored in RFW-32. The values in RFW-33, RFW-34, and RFW-35 suggest water quality constituents in the groundwater potentially resulting from the effects of previous landfilling.

An HNu photo ionization detector detected between 1.5 and 34.0 ppm of total volatile organic compounds in agitated samples from RFW-34 and RFW-35, and levels of as high as 4 ppm were recorded at the wellhead at RFW-35 during construction.

4.4.8.3 Surface Water Results - Zone 5, LF-6 and CRD-2

The surface water samples from the areas around LF-6 and CRD-2 exhibited background to low concentrations of TOX (Table 4-26). In stream locations, all O&G concentrations were at background to low levels. Iron was detected in all sampling locations in the zone on at least one occasion. Results ranged from none detected in a duplicate of SW-24 to 11.3 mg/l in SW-28. Good correlation between sampling rounds was generally found in all metals analyses of surface waters.

4.4.8.4 Contamination Profile - Zone 5, LF-6 and CRD-2

Surface water samples SW-25, SW-26, and SW-29 which monitor the CRD-2 do not exhibit evidence of water quality degradation attributable to the demolition debris disposal site. The CRD-2 is adjacent to a groundwater discharge zone as evidenced by the adjacent wetland and a static water level above land surface datum in RFW-32. RFW-32 exhibits specific conductance values above expected background. These results may be attributable to the proximity of the dump site. Based on the observed hydraulic conditions, impacts to deeper flow zones is not predicted. Although priority pollutant metals did not reveal evidence of local contamination, the moderate TOX and elevated specific conductance values pose a question regarding conclusions to be made regarding localized contaminants by VOC.

The Phase I Report (1984) states that waste solvents, thinners, and strippers were probably disposed of at LF-6. Evidence of buried five-gallon cans and 55-gallon drums was found around the perimeter and an empty portable waste fuel tank was found during the Phase II well installation pro-

gram. Wells RFW-33, RFW-34, and RFW-35, located on three sides of LF-6 (Figure 3-10), contained phenols and iron in concentrations exceeding New Hampshire MCL. The general trend of groundwater flow through the area is toward the southeast corner of the base boundary, 800 feet away. The site is underlain by low permeability marine clays and glacial till and is located in a presumed groundwater discharge zone, thus inhibiting the opportunity for contamination of deep water bearing zones.

Surface water samples from the streams and wetlands which virtually encircle LF-6 contained low to moderate levels of TOX. Phenol levels, while exceeding the New Hampshire MCL, were at or slightly above the detection limit of the analytical method. Samples from SW-24, taken upstream from the site, contained similar concentrations to those taken downstream at SW-25, SW-26, SW-27 and SW-28. It should be noted that SW-24 is downstream of SW-22 on Grafton Ditch), which is fed by the base storm drains which, in turn, services the IS/PA. Detectable lead concentrations in SW-26 through 29 may be attributable to the Spaulding Turnpike and Interstate Route 95. Measurable impacts which could be attributed to LF-6 were not detected in any of the surface water sampling results.

4.4.9 Leaded Fuel Tank Sludge Disposal Area (LFTS - Site 10) and Site 22

While examining archival aerial photographs in preparation for the test pit work at the LFTS and FDTA-1, an additional suspect former fire training area was identified adjacent to the LFTS (Figure 3-11). This site is referred to as Site 22. One of three soil samples allotted for FDTA was collected within the new site and interpretation of the results for both sites are addressed below.

A total of seven soil samples were taken from test pit and power auger holes at the LFTS and Site 22, and two rounds of groundwater samples were collected from each of the three monitoring wells. Soils and groundwater analytical results are presented on Tables 4-27 and 4-28. *In situ* measurements of pH, temperature, and specific conductance were taken during the groundwater sampling program (Table 3-7), and an HNu photoionization detector was used to screen air, soil, and water samples throughout the test pit and groundwater sampling programs.

TABLE 4-27

ANALYTICAL RESULTS

SOIL SAMPLES
LFTS SITE 22

Parameter	Detection Limit and Reporting Unit	10-B-1 11/19/84	10-B-2 11/19/84	10-B-3 11/20/84	10-B-4 11/20/84	10-TP-5 1/8/85	10-TP-6 1/8/85	22-TP-4 1/8/85
[illegible]	[illegible]-5.0 mg/kg	-	-	-	-	-	-	-
[illegible]	[illegible] mg/kg	41	50	2,220	1,980	2,370	8,720	2,480
[illegible]	[illegible]/0.02 mg/[illegible]	25.9	20.9	86.8	28.0	149	167	-

[illegible]

[illegible]

[illegible] 4.3[illegible]

[illegible] GROUNDWATER

Parameter	Detection Limit and Reporting Unit	RFW-25 3/26/84	RFW-25 5/6/85	RFW-25 8/8/8[illegible]	RFW-26 3/26/85	RFW-26 5/6/85	RFW-26 8/8/85	RFW-27 3/26/85	RFW-27 5/6/85	RFW-27 8/9/85
Oil & Grease	0.1 mg/l	0.59	[illegible]		0.21	0.45		2.09	2.14	—
Lead	0.005/0.02 mg/l	#	[illegible]	[illegible]	#	N.D.	0.018	#	N.D.	0.02[illegible]

ND - None detected

\# - Resampled due to quality control or lost samples

— - Parameter Not Specified

4.4.9.1 Hydrogeologic Conditions - LFTS and Site 22

Three monitoring wells, and eighteen test pits, power auger holes, and auger probes were installed at the Leaded Fuel Tank Sludge Disposal Area and a suspect former fire training area (Site 22) identified in aerial photos during the initial stages of the Phase II Study. The test pits and power auger probes were used to assess the local stratigraphic column, to obtain soil and water samples for laboratory analysis, and to attempt to locate an undetermined number of buried drums of sludge allegedly disposed of at the site (Figures 3-11 and 3-12). During the course of the investigation, using data obtained in the geophysical study described in Subsections 3.2.3 and 4.[illegible], three buried drums were found. Contamination associated with the drums is addressed in Section 4.4.9.2 of this report.

Logs of the three wells installed at the site (RFW-2[illegible], RFW-26 and RFW-27) indicate that the unconsolidated material beneath the site consists of kame plain deposits to depths of 22 to 30 feet below ground surface. The kame deposits are underlain by interbedded strata of marine clay, silty clay, and fine to medium sand strata, which in turn are underlain by tills. Depths to bedrock range from 40.6 feet in RFW-27 to 65 feet in RFW-26. The bedrock type, identified from core samples, consists of well foliated, gray slate with calcite stringers.

Groundwater from the site flows west/southwest toward Lower Peverly and Stubbs Pond and eventually to Great Bay (Figure 4-5). From 6 to 12 feet of saturated sands and gravel beneath the site have comparatively high hydraulic conductivity and the presence of an underlying marine clay layer probably reduces vertical flow, restricting flow of contaminants to the upper, more permeable layer. The hydraulic gradient measured between wells RFW-27 and RFW-29 is 0.017. Therefore, assuming an effective porosity of 0.30 and a typical K for clean sand of 100 ft/day, the flow velocity of groundwater and associated contaminants from the LFTS is approximately 6 feet/day.

4.4.9.2 Soil Sampling Results - LFTS and Site 22

Two soil samples (10-B-1 and 10-B-2) taken in the vicinity of the LFTS site (Figure 3-12) were analyzed for oil and grease and lead. Neither sample contained levels above the expected background concentrations. Samples 10-B-3 and [illegible]-4 were taken from an area approximately 400 feet

[illegible]

Six test pits were excavated [illegible] -B-4 (Figure [illegible]) [illegible] Three [illegible] samples were taken; sample [illegible]-TP-[illegible] was taken adjacent to the drums and [illegible]-TP-[illegible] was taken [illegible] sludge-like material [illegible] drums [illegible] mg/kg and [illegible] 144 and [illegible] mg/kg were detected in the two samples respectively. HNu readings [illegible] greater than [illegible] were recorded [illegible] drum.

Five additional test pits were excavated at Site 22 and a single soil sample was collected. Laboratory analysis of sample 22-TP-4 detected no [illegible], but it contained 2480 mg/kg of O&G. The sample was collected from a depth of four to five feet. HNu readings in excess of 50 ppm were recorded in the test pit, and as high as 50 ppm in the breathing zone. These readings were also taken during extremely cold weather conditions (5°F) and may, therefore, represent incomplete instrument responses.

4.4.9.3 Groundwater Results - LFTS and Site 22

The three wells in the vicinity of the LFTS (Figure 3-11) were sampled on two occasions. Lead analyses were not performed for from the first round; therefore, the wells were resampled for lead on 8-9 August 1985. The second round of O&G analyses for RFW-25 and both rounds for RFW-27 contained concentrations of 2.09 to 3.29 mg/l. Well RFW-25 is located approximately 50 feet west of the buried drums unearthed in the LFTS site. Well RFW-25 is within the projected groundwater flow zone from the site based on the groundwater contour map generated during the Phase II study.

[illegible] RFW-27 were [illegible] higher than those found in RFW-25, an[d] [illegible] well [illegible]. Low levels of lead [illegible] were found in all three wells. None exceeded the New Jersey MCL for lead. During the two rounds of sampling, all of the groundwater samples were screened with an HNu [illegible] presence of volatile organic compounds. RFW-2[illegible] and RFW-27 registered readings of [illegible] and [illegible], and [illegible] ppm respectively above background for the two rounds of samples. Photoionization detector (HNu) readings for RFW-25 were "none detected" and [illegible] ppm above background respectively during the two rounds of sample collection.

4.4.[illegible].4 Contamination Profile - LFTS and Site 22

The conclusions reached regarding contamination by activities at the LFTS and Site 22 are based upon soil and groundwater sampling as well as geophysical and survey work to identify a reported former leaded fuel sludge disposal area. The test pit investigation which followed the GPR investigation did not reveal evidence of area-wide sludge disposal. However, several drums were unearthed at an anomaly detected by the GPR. Soils around these drums and a sample of the drum contents exhibited elevated oil and greases and comparatively high lead concentrations. Since none of the three wells exhibited elevated lead, the migration of lead from this suspect site is not a significant concern. Lead poses a minimal risk to the underlying aquifer as it has a low solubility and would be immobilized within short distances of a source.

Oil and grease concentrations were detected in elevated concentrations at the localized drum burial site. In adjacent well RFW-25, O&G was detected in an elevated concentration (3.29 mg/l). Based on the screening protocol (O&G) and volatile organic measurements (HNu) in water from RFW-25, water quality degradation probably has resulted from past waste disposal practices. The nature and extent of these impacts and the probable extent of the source(s) impacts cannot be assessed based on current information.

Similar conclusions must be made with regard to Site 22. Site 22 appears to be a former fire training area. This conclusion is based on aerial photo analysis and site investigation results. Oils and greases in soils and groundwater and the HNu measurements in these media suggest the potential for contamination by hazardous substances. The migration po-

tential from this area is primarily through a groundwater flow pathway towards the south and west. The extent, if any, of groundwater contamination cannot be assessed with the present well array.

4.4.10 Zone 6, FMS Equipment Cleaning Site - Site 11, and Fuel Line Spill Site - Site 14 (FMS/FLS)

A total of seven soil samples, including one QA/QC duplicate sample, were collected during test pit and power auger investigations at the FMS/FLS. Soil samples collected in the FMS were analyzed for TOX and O&G. Those collected in the FLS were analyzed for O&G and VOC. Volatile analyses were performed although this protocol was not specified in the Statement of Work. Two rounds of samples were collected from wells RFW-16 and RFW-17, which are located at the FMS and FLS respectively. A QA/QC duplicate sample was also taken from RFW-17 during the second round of samples and identified as RFW-39. Well RFW-16 was sampled for TOX, TOC and O&G; RFW-17 was sampled for O&G. The analytical results are presented in Tables 4-29 and 4-30.

4.4.10.1 Hydrogeologic Conditions - Zone 6, FMS/FLS

Seven tests pits, four power auger borings, and two groundwater monitoring wells were installed at the FMS and FLS sites (Figure 3-13) to assess the nature of the stratigraphy and to collect soil and groundwater samples for laboratory analysis. Logs from the excavations and drilling indicate that the area is underlain by kame plain deposits ranging in depths from 20 to 22 feet. The kame deposits consisted primarily of fine to coarse sand with some silt, silt stringers, and gravel. A four-foot layer of sandy till was encountered in RFW-16 at the FMS site; no till was found at the FLS site. A pocket of silty clay with boulders was encountered in test pit 11-TP-6 at depths ranging from two to eight feet below ground surface. Bedrock was confirmed in both wells by coring (RFW-16) or by drilling with a tri-cone bit (RFW-17). The bedrock is described as gray to dark gray slate, and was moderately fractured.

Saturated conditions were encountered in the kame plain deposits at depths of approximately 17 feet in RFW-16 and 12 feet in RFW-17. The groundwater flow direction from the FMS site is westerly toward the main runway (Figure 4-5). RFW-17 in the FLS site appears to be located on a water table high. Flow from the site is probably toward the northeast.

TABLE 4-29

ANALYTICAL RESULTS - SOILS

ZONE 6

Parameter	Detection Limit and Reporting Unit	FMS				FLS		
		11-TP-15 10/26/84	11-TP-15A 10/26/84	11-TP-16 10/26/84	11-TP-17 10/26/84	14-B-1 4/23/85	14-B-3 4/23/85	14-B-4 4/23/85
TOX	100 ug/Kg	26,000	22,000	N.D.	N.D.	—	--	--
Oil & Grease	5-7 mg/Kg	56,700	73,600	85	50	171	1,170	10

Notes:

N.D. - None detected

Sample 11-TP-15A is a duplicate of 11-TP-15.

— Parameter not specified

TABLE 4-30

ANALYTICAL RESULTS - GROUNDWATER

ZONE 6

Parameter	Detection Limit and Reporting Unit	FMS RFW-16 4/3/85	FMS RFW-16 5/2/85	FLS RFW-17 4/3/85	FLS RFW-17 5/2/85	FLS RFW-39 5/2/85
TOX	5 ug/L	5.0	1.	--	--	--
TOC	0.5 mg/L	3.1	0.9		--	--
Oil & Grease	0.1 mg/L	0.25	0.49	0.33	0.59	0.62

Notes:

RFW-39 is a duplicate of RFW-17

-- - Parameter not specified

4.4.[illegible].2 Soil Sampling Results - [illegible] 6, FMS [illegible]

Soil samples were [illegible] duplicate samples were taken [illegible] soil at 11-TP-1[illegible]A, and [illegible] samples were [illegible] 11-TP-1[illegible], and 11-TP-1[illegible]. The analytical [illegible] elevated levels [illegible] TOX and [illegible] mg/kg, and [illegible] 73600 mg/kg, respectively [illegible] 11-TP-15 and 11-TP-1[illegible]A, [illegible] 11-TP-1[illegible] were within expected background [illegible] visual examination [illegible] indicated [illegible] inches.

Three samples collected from power [illegible] contained oil and grease at [illegible] The exact location [illegible] borings were installed [illegible] station. An [illegible] presence [illegible] plant location. Analyses detected oil and grease [illegible] 1[illegible], 11[illegible], and [illegible] mg/kg [illegible] detected [illegible] ppm at 14-B-[illegible] ppm at 14-B-[illegible]. No [illegible] detected in 14-B-4.

4.4.[illegible].3 Groundwater Results - Zone 6, FMS [illegible]

Two rounds of samples from RFW-16 were analyzed [illegible] and oil and grease, and were found to be within [illegible] background ranges. The two rounds of samples from RFW-1[illegible], plus the duplicate sample RFW-[illegible] were all analyzed [illegible] and grease. None of the three samples suggest [illegible] contamination. No floating product was detected [illegible] either well RFW-16 or RFW-1[illegible].

4.4.[illegible].4 Contamination Profile - Zone 6, FMS FLS

A limited analytical protocol was performed on soils and groundwater at the FMS FLS sites. Elevated oils and greases in soils were detected in several small stained areas of several square feet, suggesting former point discharges. At the FMS, the high O&G concentrations did not correlate with the very low TOX results (see Table 4-5 for interpretive ba-

[illegible] At [illegible], O&G in the soil sample from 14-B-3 was [illegible].

N[illegible] of contamination alleged to have occurred by disposal or spillage in the FMS FLS areas was monitored in the new wells installed in these reported sites. On this basis, the two sites are considered to be posing minimal current or future adverse impact to groundwater quality based on the screening protocols of TOX and O&G. The FMS FLS does not warrant further investigation based on the limited lateral and vertical extent of stained soils and groundwater quality monitored in this zone.

4.[illegible] CONCLUSIONS

Following are the conclusions related to the confirmation stage investigation of [illegible] sites suspected of representing an environmental problem arising from the use or disposal of materials that contain hazardous waste constituents. The [illegible] review the hydrogeologic and soil and water quality based on data collected during this investigation. Section 4.[illegible] categorizes the sites by category according to the need for further investigation and/or remediation. Investigation alternatives are reviewed in Section [illegible], and specific recommendations for each site are detailed in Section [illegible].

4.[illegible] Principal Hydrogeologic Conclusions

4.[illegible] Geologic Conclusions

Pease AFB is underlain by several unconsolidated formations of glacial origin. These are chiefly grouped in order of depositional sequence as 1) glacial till, 2) marine clays, and 3) kame plain deposits. Each of these formations have unique lithologic properties which affect the potential for contaminant migration from prior disposal sites or former areas where hazardous substances were used. The unconsolidated deposits overlie bedrock of metasedimentary origin. The bedrock underlying Pease AFB also exhibits unique hydrogeologic properties that affect the interpretation of former site use.

Much of the natural area in the vicinity of the flightline and parking aprons (Figure 1-7) has been disturbed by filling and reworking of the glacial deposits. Fill deposition has also occurred at the six base landfills and two construction rubble dumps (Figure 1-2) which were formerly or presently used for solid waste disposal sites. All of the exploratory drilling and monitoring well construction was performed beyond the limits of these fill sites. Therefore, only inferences can be drawn of the anticipated thickness of these former fill areas.

Much of the base is underlain by kame plain deposits consisting of stratified sand and gravel. These deposits overlie all other glacial strata and are, therefore, concluded to represent the most recent Pleistocene depositional sequence. The kame deposits are typically described as "fine to coarse sand and fine to coarse gravel". No consistent trend was noted with regard to change in particle size with depth. The kame deposits are moderately to highly permeable and range in thickness from approximately 4 to 35 feet. These deposits are thickest beneath the flightline and parking apron.

The kame deposits constitute a valuable, high yielding aquifer on the base. They extend off base to the north and south where they supply domestic and industrial users.

Low permeability marine clays were found in 16 of the 35 monitoring wells and Marine clays were encountered at seven of the Phase II sites. These are the LF-1, LF-6, FDTA-1, LFTS, BFSA, IS PA and the CRD-2 (Figure 1-3). The thickness of the clay stratum varied from 2 to 15 feet. The marine clays found at Pease AFB are typically described as "gray to brown with silty clay and clay with silt and fine sand lenses". Whenever encountered, the clays were underlain by glacial till.

Glacial till was encountered unconformably overlying bedrock in 20 of 35 monitoring wells installed during the Phase II Stage 1 investigation. In seven wells where the till is not encountered, RFW-6, RFW-7, RFW-8, RFW-14, RFW-17, RFW-22, and RFW-23 (Figures 3-4, 3-5, 3-8, 3-13), highly permeable kame plain deposits directly overlie bedrock. The sites where this was observed are Zone 1 (LF-2 through LF-5), Zone 3 (IS/PA) and Zone 6 (FLS). The till is described as gravelly with numerous cobbles and pebbles, and varying amounts of silt and clay. It ranged in consistency from loose to very dense and exhibited low permeabilities during

in situ slug testing. Where it was penetrated, the thickness of the till deposits varied from two to greater than forty feet. While glacial till may provide sufficient groundwater to supply domestic water supply wells in the area, (Myers, 1960), it is not utilized as a source of water at Pease AFB.

Pease AFB is underlain by metasedimentary bedrock of the Kittery and Eliott Formations. As described in Section 2.6 and verified by field inspection of bedrock cuttings and core samples, the two formations are similar in appearance and composition as well as water-bearing potential.

The bedrock was encountered near the land surface in the eastern portion of the base and near LF-1 (Figure 1-3). Outcrops were noted along the railroad tracks north of the BFSA (Figure 1-5), between wells RFW-29 and RFW-30 (Figure 1-3), and in the vicinity of the base hospital (Figure 1-2). The bedrock was encountered at the greatest depths (>74 feet below land surface) at RFW-18 in the parking apron area (Figure 3-8).

The upper five to ten feet of bedrock was found to be moderately to high fractured and is concluded to have moderately high groundwater transmitting capabilities.

In 932 wells drilled in the Kittery and Elliott Formations, the average yield was 10.1 gpm (Stewart, 1968). The MMS1, MMS2, and Loomis wells were drilled into bedrock and produce from 15 to 29 gpm with 44 to 60 feet of drawndown.

As discussed above, at six locations, kame plain sands and gravel were found overlying bedrock, thus providing the opportunity for direct communication of groundwater from the high permeability kame deposits to the fractured bedrock.

4.5.1.2 Groundwater Occurrence and Flow Conclusions

Groundwater occurs within all geologic formations on Pease AFB. Within the unconsolidated, permeable deposits, groundwater occurs principally under unconfined or water table conditions. Groundwater flow within the unconsolidated deposits underlying approximately two thirds of the base is to the south under a gradient of approximately 0.01 (Figure 4-5).

A groundwater divide occurs in the vicinity of the FLS (Figure 3-13 and 4-5). The groundwater east of the divide

flows toward the northeast at a gradient of approximately 0.018. The direction of groundwater flow west of the divide is toward the northwest at a gradient of approximately 0.023.

As previously described, the geologic formations underlying Pease AFB exhibit different water bearing properties. The kame plain deposits exhibited the highest values of hydraulic conductivity (0.2-5 feet/day). The lowest hydraulic conductivities were found in the dense silty glacial tills and marine clays (0.009-0.5 feet per day). The bedrock exhibited hydraulic conductivity properties between the most permeable and least permeable formations (0.04-2 feet/day).

The migration of water quality constituents within the groundwater flow system is based, in part, on the lithologic properties of the primary geologic strata underlying a given site. Groundwater flow velocities which were computed from the values of hydraulic conductivity, effective porosity estimates, and calculated hydraulic gradients at each site provide insight into the potential for contaminant migration from a given site. In general, the sites that are underlain by saturated kame plain deposits, such as the FDTA-1, FDTA-2, FMS, FLS, and portions of the IS/PA, possess the highest potential for migration of water quality constituents attributable to past practices since seepage velocities and total flow from those sites are concluded to be comparatively high.

Interformational flow of groundwater in permeable kame plain deposits overlying fractured bedrock is likely. In areas where low permeability marine clays and glacial tills are found, interformational flow is probably reduced and the primary flow path will be within the more permeable geologic unit. An artesian condition observed in well RFW-32 indicates that the marine clays may act as an aquitard and that a probable upward vertical gradient exists in the southeastern portion of the base. The southeastern portion of the base is concluded to be within a groundwater discharge zone. The possible restriction of the downward flow component where clays and tills are present is likely to preclude, or at least reduce, the movement of significant quantities of groundwater to the deeper flow zones.

4.5.2 Principal Conclusions: Soil and Water Quality

The following principal conclusions are drawn from the analytical data collected during the Phase II investigation:

WESTON

- The screening protocols of TOX, TOC and O&G used in the Phase II Stage 1 Study do not provide compound specific data to identify the presence and types of priority pollutant compounds which are suspected at the identified sites. A parameter specific protocol, including analysis for VOC would provide a more accurate data base from which to make site assessments.

- Phenols were detected in 13 monitoring well samples, [illegible] surface water samples, and two field blanks at levels in excess of New Hampshire's Drinking Water Standard of 0.001 mg/l. This aesthetic standard is set to protect consumers from taste and odors in chlorinated supplies. None of the samples exceeded the 3.5 mg/l toxic level established by the USEPA Water Quality Criteria Documents. It is, therefore, concluded that the phenols detected base-wide do not present a health hazard.

- Several metals were found in a number of monitoring wells at concentrations in excess of the New Hampshire's Drinking Water Standards. Iron was found in [illegible] monitoring wells, 23 surface water samples, and two field blanks. Iron limits, like phenol's are set to protect the taste and odor of drinking water and to protect against the staining of bathroom fixtures and laundry.

  Arsenic was found in two monitoring wells and [illegible] surface water samples, and lead was found in [illegible] surface water samples and the MMS-2 production well, at levels that exceed the New Hampshire MCL. These priority pollutant metals exceeded State standards in only one of the two sampling rounds. This one occurrence could be anomalously high and determination of contamination cannot be made without additional, sampling and analysis.

- No priority pollutant volatile organic compounds were detected in excess of the state MCL in any water sample. Trichloroethylene was found on two occasions in the Haven well at levels of 3.5 and 7.2 ug/l. These levels are below the New Hampshire MCL of 75 ug/l. The proposed EPA MCL of 5 ug/l was exceeded in the Haven well on one occasion. The declining trend in TCE concentrations in the Haven well from a high of 391 ug/l to the current

[illegible]

[illegible] Tables 4- and 4- [illegible] naturally occurring metals (Table 4-4).

The significance of the results based [illegible] and through laboratory screening and field [illegible] are discussed below.

4.5.3.1 Classification of Phase II Sites - Regulatory Criteria

Based upon a review of the groundwater and surface water analytical data, 12 sites have been classified as having either low, moderate, or high contamination profile based on published standards. The criteria used and those sampling points at which standards or guidance criteria were exceeded are listed in Table 4-7. The interpretation of these data is discussed in Section 4.3.3. The site classifications and rationale are listed below.

[illegible] as having a low contamination pro- [illegible] standards are:

[illegible] No. 1 - Low concentrations of phenols and iron do not represent a health risk. Low concentrations of cadmium and lead were found slightly in excess of MCL in well samples on [illegible]. Low concentrations of arsenic were also found in the upgradient well. Concentrations of nickel were attributed to "background noise".

[illegible] Fuel Tank Sludge Disposal Site/Site 22 - No lead was found in excess of criteria.

Industrial Shop Parking Apron - Low concentrations of iron and phenols do not represent a health risk. Concentrations of nickel are attributed to "background noise". Low concentrations of tetrachlorethylene are an order of magnitude below MCL. No trichloroethylene was detected in monitoring wells in Zone 3.

Construction Rubble Dump No. 2 - Low concentrations of iron and phenols do not represent a health risk. Nickel present in one sample attribute to "background noise".

o McIntyre Brook - Concentrations of iron do not represent health risk.

o Grafton Ditch - Concentrations of iron do not represent a health risk. Single copper concentration of 9.49 mg/l is not concluded to be representative of ambient water quality indicative of former waste disposal.

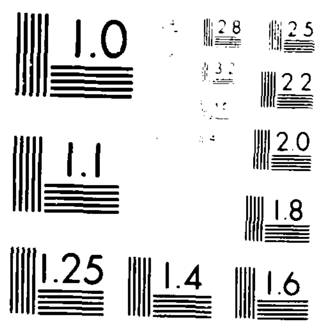
o Newfields Ditch - Concentrations of iron do not represent a health risk. Low concentrations of cadmium were detected in one sample. The second sample contained no detectable cadmium.

o Base Production Well - The well is a contaminant receptor, not a potential source of contamination. VOC found below MCL.

AD-A184 842 INSTALLATION RESTORATION PROGRAM PHASE 2 CONFIRMATION/QUANTIFICATION STAG..(U) WESTON (ROY F) INC WEST CHESTER PA R L KRAYBILL ET AL. AUG 87 4/4

UNCLASSIFIED F33615-84-D-4400 F/G 24/4 NL

END
DATE
FILMED
12 87


1.0
2.8
2.5
3.2
2.2
1.1
2.0
1.8
1.25
1.4
1.6

WESTON

The sites with a moderate contamination profile based on published standards are:

- Landfills No. 2 through 5 - Concentrations of lead, arsenic, and phenols exceeded State MCL on at least one occasion at seven surface water sampling locations. DDT isomer was detected in concentrations exceeding the water quality standard twice at the same location.

- Landfill No. 6 - Levels of phenols above New Hampshire Drinking Water Standards and within an order of magnitude of USEPA toxic limits were detected at two locations and confirmed by a second sample.

There were no sites classified as having a high potential risk to human health and the environment based upon variance from published water quality standards.

4.5.3.2 Classification of Phase II Sites - Non-Regulated Analytes

In addition to classifying sites by deviations to published standards, all other non-regulated analytes and field test results were used to develop broad classifications of sites with low, moderate, or high contamination profiles.

The sites classified as having a low contamination profile based upon *in situ* quality data, and screening protocol sampling results are:

- Landfill No. 1 - Background to low TOX, TOC and O&G were detected in wells. Background levels of TOX, TOC and O&G were found in surface waters. Specific conductance measurements in two downgradient wells were above "background." No elevated HNu readings were recorded from groundwaters.

- Landfills No. 2 through 5 - Background levels of TOX, TOC, or O&G were found in surface waters. A downstream sample contained no detectable screening analytes. No pattern of elevated TOX, TOC or O&G in groundwater samples was observed.

- Bulk Fuel Storage Area - Background concentrations of TOX, TOC and O&G were detected in surface water samples. Background concentrations of TOC and O&G were monitored in groundwater samples. Background to low values for TOX were generally found in wells. No petroleum products were observed on the water table in monitoring wells. HNu readings recorded at "background".

- Munitions Storage Area - Background concentrations of TOX and TOC were found in surface waters. Two surface waters exhibited elevated O&G values on one occasion. None were detected in the second round. Low TOX and O&G were monitored in soils. Extremely small areas (several square feet) of vegetative stress were noted. No visual impacts of contamination were observed at depth. HNu readings were "background" from soil samples obtained within the stained areas.

- Fuel Line Spill Site - No visual evidence was detected of actual effects of a large fuel spill. One soil sample elevated with O&G had no detectable VOC attributable to petroleum spillage. No floating hydrocarbons were observed in the monitoring well. Background levels of O&G were detected in two well samples. HNu readings recorded moderate (20 ppm) to "background" ranges which are not associated with visual evidence of petroleum product in soil.

- McIntyre Brook - All surface water results for TOX, TOC and O&G were at anticipated background ranges. Sediment sample results were low for TOC and low to moderate for O&G. No adverse impacts were noted by site inspection.

The sites classified as having a moderate contamination profile based upon <u>in situ</u> quality data, and screening protocol sampling results are:

- Fire Department Training Area No. 1 - Shallow soil samples contained elevated levels of TOX and O&G. Contamination appears to be confined to shallow soil stratum based on a test pit investigation. No HNu readings were recorded above background. No floating hydrocarbons

were found on the water table. Screening parameters in downgradient wells were background to low.

- Construction Rubble Dump No. 1 - A TOX concentration of 2630 mg/l in one surface water sample indicated potential contamination in the vicinity of CRD-1. This result was suported by an elevated O&G result from this location. A downstream sample collected at the same time exhibited an elevated O&G result. The other analytical results were within expected background concentration ranges. No visual evidence of contamination was observed in the area of the CRD-1.

- FMS equipment cleaning site - Elevated levels of TOX and O&G in duplicate samples and black stained soil verify past disposal of wastes. Stained soil is confined to a small area (<300 square feet) and appeared to impact only the upper one foot. No visual evidence of soil contamination was found at depth. No odors were detected and no floating product was observed in the monitoring well. Background concentrations of TOX, TOC and O&G were detected in the monitoring well.

- Construction Rubble Dump No. 2 - Low to moderately elevated TOX and elevated specific conductance were detected in groundwater. Background readings were measured on the HNu.

- Grafton Ditch - Elevated TOX and O&G were measured at one sediment sampling point. Oily sheens on the surface water and petroleum-like odors were observed during sediment sampling. Surface water samples contained no detectable TOX, TOC, or O&G.

- Newfields Ditch - Elevated concentrations of TOX and O&G were found in sediment samples; none detected in surface water. The ditch flows through the base housing area.

The following sites were classified as having a high contamination profile based on screening protocol data, <u>in situ</u> quality data, and soil sampling analytical data:

- Landfill No. 6 - Elevated concentrations of TOX and TOC and low concentrations of O&G were

detected in both rounds of groundwaters. Specific conductance values were measured in wells, significantly above background. HNu readings from wells were observed above "background". Surficial evidence of drum disposal was observed during drilling and sampling.

- Fire Department Training Area No. 2 - Low to elevated levels of TOX, TOC, and O&G were detected in downgradient wells and low to elevated levels of TOX and O&G were found in soils. HNu readings registered to 170 ppm during sampling operations. An area of approximately one-half acre of oil-stained soil extending to at least a depth of nine feet, was observed in the test pit investigation. The site lies within 800 feet of the base boundary and is underlain by stratified sand and gravel.

- Leaded Fuel Tank Sludge Disposal Site and Site 22 - Elevated concentrations of O&G were detected in two wells and elevated O&G concentrations were found in soil samples from both sites. HNu readings of 16 to 50 ppm were registered during groundwater sampling and test pit excavation. The site is underlain by stratified sand and gravel and is upgradient of lower Peverly Pond. At least three buried drums were encountered during test pits operations and were found to contain concentrations of lead and O&G.

- Industrial Shop/Parking Apron - Low to elevated concentrations of TOX and O&G were detected in soil samples from seven locations within the site. Phenols were found in soil samples collected near buildings 119 and 120 at concentrations that are in order of magnitude above these found elsewhere in the site. Concentrations of VOC ranging from 4.0 to greater than 70,000 ug/kg were detected at four sites. Concentrations of up to 100 ppm were registered on an HNu during sampling operations. One underground storage tank contained liquid exhibiting elevated concentrations of TCE and trans-1,2-dichloroethylene.

WESTON

4.5.3.3 Summary of Site Classification

The data cited in Subsections 4.5.3.1 and 4.5.3.2 was used to categorize Phase II sites at Pease AFB. This is discussed in Section 4.5.4 of this report.

4.5.4 Site-Specific Categorizations

As a conclusion to the investigation, each of the sites investigated can be categorized according to whether it requires no further action (Category I), requires further investigation (Category II), or is ready for remedial action (Category III). Sites may be subsequently recategorized at the end of each successive stage of the Phase II investigation until all are ready for remedial action (Phase IV of the IRP investigation) or no action. The following definitions have been used in the classification of investigation sites at Pease AFB:

- Category I applies to sites where no further action (including remedial action) is required.
- Category II applies to sites requiring additional investigation to quantity or further assess the extent of current or future contamination.
- Category III applies to sites where remedial action is required and all necessary data to support an analysis of remedial alternatives have been gathered. These sites are considered ready for IRP Phase IV action.

Site-by-site conclusions are summarized in Table 4-31, which lists a category for each site, presents the rationale for that categorization, and references the report subsections that present supporting evidence for that categorization. Investigation alternatives for each category are reviewed in Section 5, an1 site-specific recommendations are presented in Section 6.

Table 4-31

SUMMARY OF SITE-SPECIFIC CONCLUSIONS
PEASE AFB, PHASE II, STAGE 1 IRP INVESTIGATION

Zone	Site	Investigation Category	Rationale	Supporting Sub-sections of Report
	FDTA 2	II	Contamination of soil and groundwater by screening protocols of TOX and O&G, potentially capable of offsite migration. Potential for contamination of fractured bedrock aquifer. Further investigation needed to identify specific contaminants lateral and vertical distribution, hazard level and to recommend source containment/removal options	4.1.2., 4.3.3., 4.4.1.
1	BFSA	I	Results of TOX, TOC and O&G analyses indicate no significant contamination problems in wells and surface water. to monitor groundwater quality downgradient of site.	4.1.2., 4.2.2., 4.3.3
1	LF-2, LF-3 LF-4 and LF-5	II	Contamination of surface water by low levels of As, Pb and DDT isomer. Orange precipitate suggests presence of landfill leachate. Further investigation necessary to confirm and quantify surface water quality impacts relative to hazardous substances. No groundwater contamination detected. Wells appropriately sited to monitor groundwater downgradient of sites.	4.1.2., 4.2.2., 4.3.3
2	FDTA 1	II	Screening protocols in downgradient well at "background". Soil contamination by O&G is elevated. Further investigation necessary to identify specific contaminants posing hazard, if any, and to evaluate any potential hazards from direct contact or through runoff. Possibility of ground water discharge to Peverly Pond and/or unnamed stream north of site.	4.1.2., 4.2.3., 4.3.3

Table 4-31 (cont.)

SUMMARY OF SITE-SPECIFIC CONCLUSIONS
PEASE AFB, PHASE II, STAGE 1 IRP INVESTIGATION

Zone	Site	Investigation Category	Rationale	Supporting Sub-sections of Report
2	LF-1	I	Downgradient wells exhibit background to low TOX, TOC and O&G. Low TOX, TOC, and O&G detected in surface waters. Specific conductance and iron concluded to be above background in downgradient wells. HNu readings at wells within "background" values. No significant impacts on surface water quality detected. Priority pollutant metals detected in various concentrations in up and down-gradient wells not concluded to be directly attributable to LF-1.	4.1.2., 4.3.3., 4.4.3
3	IS/PA	II	Contamination by screening protocols (TOX and, O&G), selected metals, phenols and Priority Pollutant VOC in soils at up to 7 locations: Building 113 - O&G, VOC Building 119 - TOX, O&G, phenols, VOC Building 120 - TOX, O&G, phenols, lead Building 222 - TOX, O&G, VOC Building 226 - TOX Building 229 - O&G Building 244 - VOC Groundwater quality throughout the zone was consistent with anticipated background quality. Elevated concentrations of contaminants in soils presents the possibility of future bedrock and/or unconsolidated aquifer contamination. Proximity of areas of contamination to drainage ditches present the possibility of localized flow discharge of contaminants.	4.1.2., 4.3.3 4.4.4.

Table 4-31 (cont.)

SUMMARY OF SITE-SPECIFIC CONCLUSIONS
PEASE AFB, PHASE II, STAGE 1 IRP INVESTIGATION

Zone	Site	Investigation Category	Rational	Supporting Sub-sections of Report
			One underground storage tank (Building 244) contains a liquid with elevated VOC (Table 4-14). Further investigation necessary to determine extent of significant soil contamination and possible impacts on receptors including surface water quality in areas where VOC detected.	
4	McIntyre Brook	I	Results of TOX, O&G, TOC at background and all metals within state MCLs in surface water. O&G in sediment background to low. No visually stressed conditions observed. Storm drainage passes through oil separator prior to discharge to brook. Brook sampled as part of base NPDES program.	4.4.3., 4.4.5
4	Newfields & Grafton Ditches	II	Elevated levels of TOX, O&G and lead detected in sediments. Oil sheen on surface water during sediment sampling. Further investigation necessary to quantify sediment quality and determine potential impact on surface water quality.	4.4.3., 4.4.5
4	Base Production Wells[(1)]	I	Lead detected at state MCL in MMS-2 on one occasion but not detected during second round. No other contamination detected in excess of State MCLs. Low levels of VOC found in Haven, MMS1 and Loomis wells. Base personnel sample all production wells quarterly for VOC. Discharge from Haven, Harrison and Smith wells is treated for VOC at Base treatment facility. No further IRP investigation recommended.	4.4.3., 4.4.5

Table 4-31 (cont.)

SUMMARY OF SITE-SPECIFIC CONCLUSIONS
PEASE AFB, PHASE II, STAGE 1 IRP INVESTIGATION

Zone	Site	Investigation Category	Rationale	Supporting Sub-sections of Report
	MSA	I	Low concentrations of TOC and O&G detected in soils in stained areas. Lateral and vertical extent of soil staining very limited. HNu readings at "background " in power auger holes. Background concentrations of TOX and TOC in surface waters. Oil and Grease results in surface water variable and not concluded to be attritutable to suspect site based on site investigation. No further IRP action warranted.	4.1.2., 4.3.3. 4.4.6
	CRD 1	II	Second round surface water sample from SW-10 contained elevated TOX. Resamples from SW-10 and SW-12 (Figure 3-17) contained elevated O&G. All surface water samples potentially in downgradient groundwater flow path from CRD 1 and FDTA 2. Additional sampling with specific protocols (VOC, BNA) required to identify, and to assess potential impact to Upper Peverly Pond (located downstream of SW-10).	4.1.2. 4.3.3. 4.4.7.
	CRD 2	I	Low TOX detected in downgradient well adjacent to fill deposits but HNu Readings at "Background" from well. Background TOC and O&G in well. Elevated specific conductance values in ground water from well but no priority pollutant metals exceeding state MCLs attritbutable to fill operations. Site in ground discharge zone. Background concentrations of TOX, TOC and O&G in adjacent surface waters.	4.1.2., 4.3.3 4.4.8

(1) Potential Receptor; not a site.

Table 4-31 (cont.)

SUMMARY OF SITE-SPECIFIC CONCLUSIONS
PEASE AFB, PHASE II, STAGE 1 IRP INVESTIGATION

Zone	Site	Investigation Category	Rationale	Supporting Sub-sections of Report
5	LF-6	II	Contamination in ground water by TOX, TOC, O&G, phenols and in-situ measurements (specific conductance and VOC by HNu). Site within 1800 feet of Base boundary and abuts wetlands. Further investigation necessary to identify specific compounds, to define vertical and horizontal ground water flow patterns, and quantify nature and extent of contamination by hazardous substances.	4.1.2., 4.3.3 4.4.8
	LFTS and Site 22 (Suspect Fire Training Area)	II	Elevated O&G detected in two wells near sources. Elevated O&G concentrations in soils near two sources. Elevated HNu readings during well drilling and test pits investigations. Buried drums encountered during test pit operations. Site underlain by permeable sand and gravel. Additional investigation necessary to identify specific VOC compounds if any and define extent of contamination in soils and waters. Confirmation of all potential drum burial sites.	4.1.2., 4.3.3., 4.4.9
6	FLS	I	Elevated TOX level in one small area of stained soil (1-2 ft. diameter). No VOC's detected in sample from the same site. No contamination by O&G found in downgradient monitoring well.	4.4.10
6	FMS	I	Elevated TOX and O&G concentration in soils in isolated stained area. Low TOX, TOC, O&G in well samples. Visual examination of soils beneath stained area indicate no contamination with depth. Groundwater results do not reveal evidence of contamination.	4.4.10

(1) Potential receptor; not a site.

SECTION 5

ALTERNATIVES

5.1 General

Based on the results of this investigation, 20 sites (including Site 22, the suspect fire training area discovered during the Phase II study) have been classified into one of three possible categories: Category I, requiring no further action; Category II, requiring further investigation; or Category III, requiring remedial action. Of the 20 sites considered, seven fell into Category I and the remaining thirteen fell into category II and thus require further investigation. This section reviews the principal investigation alternatives which may be applicable to Category II sites at Pease AFB.

Table 5-1 summarizes the types of site investigation alternatives commonly available. These alternatives are further described by their conditions of applicability (when are they most useful) and the rationale for recommendations (what are the anticipated benefits). Eight alternatives are potentially applicable for consideration at Pease AFB. These are: 1) additional sampling at existing monitoring points, 2) expansion of the current monitoring network, 3) aerial photo analysis, 4) analyses of receptors, 5) non-destructive testing, 6) soil gas testing, 7) groundwater modeling, and 8) other studies such as aquatic biological investigations. The following subsections review the rationale affecting the selection of priority investigation alternatives and the development of specific recommendations at the fourteen sites determined to require further investigation (Category II).

5.2 SITE-SPECIFIC ALTERNATIVES

5.2.1 Fire Department Training Area No.2

Based upon screening protocol sampling data, field observation, and *in situ* monitoring of soils and groundwater from the Phase II investigations, it is evident that past practices at the FDTA-2 have resulted in soil and groundwater contamination based on the screening protocol analysis. The items of concern which affect the selection of

TABLE 5-1

SUMMARY OF INVESTIGATIVE ALTERNATIVES

FOR CATEGORY II SITES

INVESTIGATION ALTERNATIVE	CONDITION(S) OF APPLICABILITY	RATIONALE FOR RECOMMENDATION
Supplemental Monitoring of Existing Monitor Points (Limited Repeat Stage 1 Monitoring)	Data from the site is insufficient to determine the nature of the problem, if any. Repeated analysis are necessary to confirm the presence or trend of particular hazardous substances.	May be used to recategorize site and define a specific rationale for future action with respect to other alternatives (including no action). May be used to confirm and monitor current situation.
Expansion of Existing Monitoring Network (soil, groundwater, surface water, particulate via air and water pathways)	Contamination from a Stage 1 site has been characterized but the extent of contamination is uncertain and the pathways of migration are ill-defined.	Additional monitoring points may proved new quantitative physical and chemical data in the lateral and vertical dimensions for determining the distribution of contaminants in and beyond the site. This level of effort is essential at certain sites where developing remedial alternatives and monitoring the effectiveness of remedial actions is required.
Aerial Photo Analysis Photo interpretations include fracture trace (fabric) analysis	Contamination is confirmed but specific site location is uncertain. Information indicates potential hazardous substance migration into bedrock or where data shows remedial actions are required for control or recovery of pollutants in the bedrock flow regime.	May be used to strategically place bedrock monitoring wells or recovery wells and assess anisotropic flow in bedrock.
Receptor Analysis	Data suggests potential off site migration by known hazardous substances or previous "slug" discharges. Data indicates pollution but receptors undefined.	May be used to determine the impacts on receptors or level of action necessary to ensure protection of existing or future resources (endangerment assessment).

TABLE 5-1 (Cont.)

INVESTIGATION ALTERNATIVE	CONDITION(S) OF APPLICABILITY	RATIONALE FOR RECOMMENDATION
Non-Destructive Testing Geophysical methods including borehole geophysics	Existing data cannot locate source(s) of contaminations.	Geophysical techniques may be used to screen sites and identify anomalies for sources definition (e.g. identify buried drum sites).
	Existing data points cannot comprehensively describe extent of problem.	
	Existing data insufficient to accurately characterize subsurface geology and potential flow pathways.	Geophysical techniques may be used to delineate contaminant dispersion over wide areas.
		Geophysical techniques may assist in "extending" the interpretation of stratigraphic information from a limited number of data points (borings).
Soil Gas Testing	Contamination from a site has been confirmed but additional information is needed to quantify the nature and extent of contamination.	Soil gas testing may provide initial screening of the site for the presence of volatile organic compounds in soil and/or groundwater.
		Soil gas testing may be used to delineate the extent of soil and/or groundwater contamination of volatile organic compounds present on-site and migrating off-site.
Groundwater Modeling	Contaminants of concern have been identified and sufficient data exists to establish model parameters. Existing data cannot easily predict anticipated conditions on a mathematical basis.	Groundwater modeling may be applicable to situations where multi-variant analyses of data will improve site-source quantification efforts or estimates of migration potential.
Other Field Investigations Aquatic Hydraulic Air Tracer Topographic	Dependent on site specific needs. Particularly useful after the specific nature of contamination has been defined.	May be used indirectly to enhance other field investigation techniques to quantify potential effects of contamination receptors and assist in determining extent of remediation, if any.

alternatives at the FDTA-2 include the oil stained soils in the low-lying wooded area located northeast of the site, the soils beneath the currently used burn area, and the groundwater beneath and downgradient of the site.

The *in situ* and laboratory data collected confirm that soils in the low-lying wooded area located north of the FDTA-2 (Figure 5-4) have been contaminated by runoff and discharges from the burn area. Non-specific analyses suggest the contamination is petroleum based products. Identification of the presence of chlorinated solvents or other hazardous substances could not be ascertained with the current analytical protocols. The areal extent of the problem and the nature of the specific compounds present at the site must be determined before remedial options such as removal, treatment, or capping of the wastes can be recommended.

No soil samples were taken from the current burn area of the FDTA-2 during the Phase II study. It is likely that past operations at the site have resulted in contamination of the soils beneath the clay liner. It is also possible that the burning of chlorinated solvents has resulted in the generation of potentially harmful decomposition products which may be hazardous at low concentrations. Specific analyses for hazardous components need to be performed before recommendations (including No Action) can be made.

The screening protocol data (Table 4-5) indicates groundwater at downgradient well RFW-10 has been contaminated by O&G and TOX. The TOX concentrations are above anticipated background. Depending on the specific nature of these substances, off-site migration is a concern since groundwater flow rates suggest the base boundary, 1,000 feet from the site, is within the zone of influence of the FDTA-2. Based upon the above concerns the following primary alternatives were considered:

1. Re-evaluation of archival aerial photographs in light of the Phase II, Stage 2 contamination profile.

2. A test pit and soil sampling study to identify the specific waste components in the soil and their lateral and vertical extent.

3. Shallow borings to facilitate deeper sampling and to limit site disruption.

4. Soil gas monitoring for VOC during test pit and shallow boring operations to provide rapid access to analytical data during the quantification portion of the field study.

5. Resampling of existing wells to identify the specific hazardous substances of concern, if any.

6. Performing a fracture trace analysis to evaluate the extent of major bedrock fracture zones and to determine probable groundwater flow directions in the bedrock.

7. Siting, installing, and sampling of multi-level monitoring wells to evaluate the vertical contamination profile, the areal extent of the contaminant plume, if any, and the groundwater flow regime at the site.

8. Sampling of privately owned off-base wells to determine if contamination from the site is adversely impacting off-base water quality.

9. Performing a receptor analysis to provide the basis for an endangerment assessment to evaluate required cleanup levels.

A combination of the alternatives cited above will provide the data necessary to determine the quantity of contaminated soil and to identify the specific compounds present at the site, prior to recommending remedial options such as capping the site, source removal, or in situ groundwater/soil treatment.

Alternatives 1 - 5 and 7 are the most reasonable priority actions to consider at this time. Until site specific parameters of concern can be determined, the other alternatives may be inappropriate.

5.2.2 Landfills LF-2, LF-3, LF-4, and LF-5 (4 Sites)

Phenols, selected metals, and pesticides were detected in surface water samples collected from ditches which flank LF-2 through LF-5. Chemical results of sampling show an inconsistent pattern to the presence of these compounds. The following alternatives have been considered:

1. Resampling at all or selected monitoring points within the zone.

2. Installation of additional monitoring wells and surface water sampling points.

3. Performing a receptor analysis to identify the basis for future actions, if any.

The low concentration of the priority pollutant compounds detected during the Phase II study do not warrant large scale resampling of the surface water. The water quality at SW-9, located near the base boundary (Figure 3-5) met all Federal and State standards. Furthermore, no groundwater quality problems were observed that would necessitate the installation of additional wells. It was concluded that the primary alternative is to collect additional samples at surface water sampling site SW-8 and that they should be analyzed for VOC, priority pollutant metals, and pesticides/herbicides. This sampling could be incorporated into the base NPDES sampling program, thereby reclassifying LF-2 through LF-5 to Category I. If recurrent contamination is found at significant concentrations, further remedial alternatives such as capping of the landfills could be considered at a later date. Non-IRP related closure activities for solid waste facilities may be considered by the base.

5.2.3 Fire Department Training Area No. 1

Shallow soil samples from test pits at the FDTA 1 contained elevated levels of TOX and O&G. Monitoring well RFW-28 located hydraulically downgradient of the site did not contain significant levels of the screening protocol analytes. Base records report that waste fuels, oils and solvents were burned at the site. The possibility, therefore, exists that hazardous compounds may be present in the soils at the site. The analytical limitations affecting the interpretive results for the FDTA 2 also apply to the results obtained for the FDTA 1.

Based upon the results of the Stage 1 investigation the following alternatives were considered for the FDTA 1:

1. Additional test pit/soil borings within the site to identify the particular hazardous substances of concern, if any, and their lateral and vertical extent.

2. Collection and analyses of additional surface water and groundwater samples for specific suspect hazardous compounds of concern.

3. Soil gas testing in and around the FDTA-1 to identify specific hazardous compounds.

4. Installation of additional monitoring wells to further define groundwater flow and potential water quality impacts.

Based upon a computer generated water table contour map, well RFW-28 is situated in the groundwater flow zone downgradient of the FDTA-1. Since evidence of contamination was not detected it is, therefore, concluded that additional groundwater monitoring wells would not provide significant new data at this time. Due to the length of time since fire training operations have ceased at the FDTA-1, and the nature of the underlying material (sand and gravel) it is likely that any VOC which might be detected by soil gas monitoring have either volatilized from the soil or have migrated downward.

Further test pit excavation soil sampling, and ground and surface water sampling with an expanded analytical protocol are priority alternatives (1 & 2).

5.2.4 Industrial Shop/Parking Apron

During the course of the Phase II study it became apparent that a number of smaller subsites were found to be contaminated by various organic and inorganic compounds.

The analytical protocol specified for the site was sufficient to identify individual priority pollutant organic compounds which are mobile and detectable at low concentrations.

Eight subsites in Zone 3 were investigated. No evidence of contamination was detected at Building 234. Seven subsites were identified as suspect sites during the Phase II study and each is described below:

1. Building 244 is the site of an abandoned, waste TCE tank found to contain TCE and trans-1,2-dichloroethylene and has historically been considered a potential source of TCE in the base water supply.

2. Building 113 is the site of a second abandoned, underground waste TCE tank which has been filled with sand. A sample of saturated sand contained low concentrations of TCE and trans-1,2-dichloroethylene. Soils from an area north of the tank contained low concentrations of volatile organic compounds, including TCE. The subsite is located within 100 feet of a small wetland area.

3. Building 229 is the site of a buried, oil/water separator. Elevated levels of volatile organics were registered on an HNu photoionization meter during power auger boring operations, and petroleum-like odors and stained soil material were noted during the sampling of the borings. However, no priority pollutant volatile organics were detected in the soil's sample.

4. Elevated levels of hydrocarbon compounds were detected in a soil sample taken from a power auger boring south of Building 222. Base personnel working near the subsite reported that it was the site of a fuel spill. The WESTON laboratory reported "very high concentrations of hydrocarbons," but was unable to quantify toluene and ethyl benzene. Two drainage ditches begin within 200 feet of the subsite.

5. Field monitoring of air quality with an HNu at a boring south of Building 226 produced a reading at 60 ppm in the power auger hole. However, no priority pollutant VOC was detected in three soil samples from this area. Building 226 is the site of a waste solvent drum staging area.

6. A staging area for waste solvent and oil containers is located in the paved area

south of Building 119. A soil sample taken adjacent to the staging area from a power auger boring contained over 70 mg/kg of total volatile organic compounds. The subsite is located approximately 100 feet north of a storm drainage ditch.

7. Building 120 contains the Base paint shop and it is alleged that waste paints, strippers, and solvents had been dumped on the ground outside the shop door. A soil sample taken in the area of the alleged dumping contained elevated levels of TOX. However, no priority pollutant volatile organic compounds were detected in a soil sample.

The following alternatives have been considered for this zone.

1. "Expedited removal" of the contaminated liquid and soils from the tanks at Buildings 244 and 113. Excavation and removal of the tanks, screening of the soils beneath the tanks for VOC and transporting of all related waste material to an approved hazardous waste disposal site.

2. Installation of supplemental auger borings or test pits to allow sampling and characterization of soils with depth.

3. Soil gas testing to determine the areal extent and concentration of VOC contamination in soils at specifically localized subsites.

4. Expansion of the analytical protocol to detect additional compounds unspecified in the Phase II Stage 1 study.

5. Designation of surface water and sediment sampling points with sampling protocols similar to those used in the Phase II Stage 1 study, to evaluate the potential adverse impacts of selected subsites on surface waters.

6. Supplemental monitoring of selected existing wells and/or piezometers within the site for specific compounds of concern.

WESTON

7. Installation of additional, multi-level monitoring wells to characterize local groundwater flow in the kame deposits and in the bedrock, and to allow groundwater quality sampling at various depths for specific compounds of concern.

A priority alternative to consider is the "expedited removal" of the underground TCE storage tank at Building 244. The tank at 113 does not appear to contain significant contaminants.

Soils analyses and soil-gas testing at the seven subsites in the IS/PA would be necessary to delineate the extent of contamination before recommendations concerning source control/removal could be made. The use of auger borings rather than test pits to obtain soil samples is recommended in the IS/PA, to minimize disturbance to lawns around the shops and flight line area. Soils analyses must be compound specific so action levels can be assessed. The drainage ditches near Buildings 222, 113, and 119 require sampling to determine if surface water and/or contamination has resulted from past base operations.

An abandoned public water supply well point system near Building 229 and six existing temporary monitoring points would provide sampling points for collecting additional water quality data during soil gas testing investigations. Additional, multi-level wells may be necessary to adequately monitor vertical and lateral flow patterns and possible contaminant migration. This should be a lower priority pending the results of soil testing.

5.2.5 Newfields and Grafton Ditches (2 Sites)

Newfields and Grafton Ditches carry rainfall runoff and storm drainage from the IS/PA. Sediment from them contained elevated TOX and lead levels and produced on oily sheen on the water when disturbed during sampling. The surface water samples from the same area indicated no contamination problems, and it is likely that contaminants are confined to sediments.

The alternatives considered for these two drainage ditches include:

1. An expanded sediment sampling program to determine the vertical and lateral extent of contamination within the sediments.

2. An expanded analytical protocol, including VOC and base/neutral and acid extractable compounds, to identify the specific contaminants.

3. Resampling of surface water sites to confirm water quality assumptions.

4. An aquatic biological investigation of macroinvertebrates to assess the extent, if any, of downstream impacts.

5. A receptor analysis as a basis for performing an endangerment assessment prior to recommending remedial control alternatives, if any.

The extent of the contamination problem, both laterally along the stream channel and with depth, should be determined prior to any consideration of remediation. The nature of the sediments must be ascertained to determine if a potential risk to human health and/or the environment exists, and to determine what constraints may be placed on future remedial options. If removal of the sediments is recommended, based on the results of the additional sampling, further study may be required to evaluate the potential impact to the stream biota or other potential downstream receptors.

5.2.6 Construction Rubble Dump No. 1

A single surface water sample from SW-10 (Figure 4-5) on Peverly Brook contained 2630 ug/l TOX. The sampling point may be in the flow path of groundwater from the CRD-1 and the FDTA-2. Flow from the brook discharges to Upper Peverly Pond. The following alternatives have been considered:

1. Expansion of the surface water sampling network at the site and expansion of the an analytical protocol to fully characterize the contaminants found at SW-10.

2. Installation of monitoring wells to determine if contaminated groundwater is discharging to Peverly Brook.

3. Performing an aquatic biological investigation of the stream.

4. Inclusion of the additional sampling of the site in the base NPDES program and placing of the site into Category I.

Alternative 1 was considered to be the most viable action to consider at the present time. It has been concluded that there is insufficient data to warrant t[illegible] installation of monitoring wells at this time. Additio[illegible] sampling of the existing monitoring network with an expanded analytical protocols recommended. If recurrent surface water contamination is detected, a full quantifications study may be required.

5.2.7 Landfill LF-6

Groundwater samples from three wells near LF-6 contained significantly high concentrations of TOX, TOC, O&G, and phenols. During the installation and sampling of the wells, elevated HNu readings were noted in all three wells. TOX and O&G samples from surface water samples collected from the wetlands southeast of the site exceeded background levels. The following alternatives have been considered:

1. Aerial photo analysis to assess past site conditions and perform a fracture trace analysis.

2. Test pit excavation to define the limits of the landfill and provide soil sampling points at various depths.

3. Installation of multi-level monitoring wells to determine groundwater flow characteristics and to provide multi-level groundwater sampling points.

4. Field soil gas monitoring to identify any volatiles at the source during the test pit investigation.

5. Expansion of the analytical protocol to fully characterize the wastes at the site relative to hazardous substances, if any.

6. Moving the surface water sampling points closer to the landfill to provide more representative analytical data.

7. Sampling all existing and new wells and surface water sampling points for full Priority Pollutant Analyses.

8. Performing geophysical investigations at the site to locate drums, if any, and characterize site geologic conditions beyond borings.

9. Groundwater modeling to evaluate contaminant migration potential.

A full quantification study including additional sampling points, multi-level well installation, source quantification, soil gas monitoring, and expanded analytical protocol is recommended for LF-6. Items 1-7 should be given priority consideration at the present time. The results of the study will be used to consider remedial options or additional study.

5.2.8 Leaded Fuel Tank Sludge Disposal Site (LFTS) and Site 22 (2 Sites)

The LFTS and Site 22 are considered together in this section due to their proximity to one another and the presence of similar suspect priority pollutants. The LFTS site was used for the disposal of sludges from the base leaded fuel supply tanks. The sludge was placed in 55-gallon metal drums and buried or spread on the ground and allowed to weather. A nest of at least three buried drums was detected during the Phase II geophysical investigation and confirmed during test pit operations. Site 22, an area of stained soil approximately 50 feet in diameter was noticed during the review of archival aerial photographs. Soil samples from both sites contained elevated HNu readings in agitated water samples. The following alternatives have been considered:

1. A detailed historic aerial photo analysis of the site with detailed description of suspected conditions.

2. An expanded geophysical investigation to assure other buried drums are not present.

3. "Expedited removal" of the buried drums. The drum contents should be characterized, placed in suitable containers, and if warranted by the analytical findings, transported to an approved hazardous waste disposal facility. Soil beneath and around the drums should be analyzed for hazardous material and removed and containerized as necessary.

4. Additional test pit and soil boring and sampling operations with soils' analyses and field soil gas monitoring to determine if significant quantities of contaminated soil occur beneath the sites. Collection of soil samples for laboratory analysis for VOC, base/neutral and acid extractable compounds, and lead to fully characterize the site.

5. Sampling of existing monitoring wells for an expanded analytical protocol to identify the specific constituents of concern.

6. Installation of multi-level monitoring wells to evaluate local groundwater flow patterns and to determine the areal extent of the contaminated groundwater, if any, beneath the site.

7. Groundwater modeling to quantify contaminant flow and dispersion, if any.

8. Receptor analyses as a basis for feasibility study options.

Alternatives 1 to 5 are recommended for priority consideration. A full quantification study, including Alternatives 6 to 8 may ultimately be required if contaminated groundwater is migrating off-site. The buried drums might be removed on an "expedited remedial basis". Additional remediation such as removal of contaminated soils, other drums, or *in situ* soil or groundwater treatment may be required, pending the results of the expanded sampling program.

WESTON

SECTION 6

RECOMMENDATIONS

As a result of the IRP Phase II Stage 1 investigation at Pease AFB, 13 sites were identified which were classified in Category II warranting further investigation. The rationales justifying selection of eight alternatives have been reviewed in Section 5. These investigative alternatives are: 1) additional sampling at existing monitoring points, 2) expansion of the current monitoring network, 3) reassessment of aerial photo analysis, 4) analyses of receptors, 5) non-destructive testing, 6) soil gas testing, 7) groundwater modeling, and 8) other studies. This section presents recommendations for implementation of these alternatives on a site-by-site basis. In addition, two subsites (buried tank at Building 244 and the buried drums at the LFTS) have been prioritized for "expedited remedial action" within the context of a Category II site.

6.1 GENERAL RECOMMENDATIONS

The use of TOX, TOC, and oil and grease (O&G) analyses has been used as a screening methodology to indicate the presence of organic compounds in soil or water. The Stage 2 sampling protocols should be compound-specific for the parameters of concern. The recommended analytical protocols may change subject to review of the Stage 1 Report and the evaluation of priorities. The multi-level well installations which are recommended may also function to assess overall base-wide water quality with respect to hazardous waste constituents.

6.2 SITE SPECIFIC RECOMMENDATIONS

Site specific recommendations for further field investigations at 13 sites have been summarized in Table 6-1. The rationales for planning or recommending additional wells are addressed in Sections 4 and 5. Additional wells should be constructed of the same materials as were used in the Stage 1 monitoring wells. The analytical protocols are based on the Phase I and II, Stage 1 findings.

TABLE 6-1

SUMMARY OF INVESTIGATION RECOMMENDATIONS

Zone	Site	Recommendations	Level of Effort
-	Site 8- FDTA2	o Air photo reassessment	o Fracture trace analysis
		o Resampling of existing wells	o 2 rounds - full quantification effort for VOCs, BNAs, PNAs, PCBs and GC fuels analysis (10 samples)
		o Install additional monitoring wells	o Three multi-level well installations and sampling; six samples for VOCs, BNAs and GC fuels analysis.
		o Test pit/soil sampling in burnpit	o Full quantification effort for VOCs, BNAs, PNAs, PCBs, and GC fuels analysis (10 samples)
		o Soil gas testing	o Field GC analyses to complement quantification effort
1	Sites 2,3,4,5 - LF-2, LF-3, LF-4, LF-5	o Resampling surface waters and groundwaters	o Resample at three locations, 2 occasions for VOCs, Herbicides/Pesticides and selected metals

Notes: VOC = Volatile Organic
BNA = Base Neutral/Acid Extractables
PNA = Polynuclear Aromatics
PCB = Polychlorinated Biphenyls
GC = Gas chromatography

TABLE 6-1 (continued)

SUMMARY OF INVESTIGATION RECOMMENDATIONS

Zone	Site	Recommendations	Level of Effort
2	Site 7 - FDTA1	o Resampling of surface and groundwaters	o 2 Rounds - 10 samples for VOCs, BNAs and PNAs
		o Supplemental soil borings/test pits	o Full quantification efforts for VOCs, BNAs, and PNAs (10 samples)
		o Soil gas testing	o Field GC analysis to complement quantification effort.
		o Install additional monitoring wells	o Three multi-level well installations and sampling; 6 samples for VOCs, BNAs and PNAs.
3	Site 15 - IS/PA	o "Expedited Remedial Action" at buried tank at Building 244	o Removal and testing of liquid contents (RCRA), testing of soils for VOCs around tank
		o Soil borings/soil sampling	o Localized quantifications study at seven potential sources for VOCs, BNAs and selected metals
		o Soil gas testing	o Field GC analyses to complement quantification analyses

Notes: VOC = Volatile Organic
BNA = Base Neutral/Acid Extractables
PNA = Polynuclear Aromatics
PCB = Polychlorinated Biphenyls
GC = Gas chromatography

TABLE 6-1 (continued)

SUMMARY OF INVESTIGATION RECOMMENDATIONS

Zone	Site	Recommendations	Level of Effort
3	Site 15 (cont.)	o Surface water/sediment sampling	o Confirmation level effort at sites adjacent to wetlands/streams (Bldgs. 222, 113 and 119, 229)
		o Resampling existing monitoring	o 2 rounds - 14 samples for VOCs and selected metals; 7 samples for BNA
		o Removal of tank at Building 113	o Tank removal, if warranted by supplement investigations
		o Install additional wells	o Four multi-level well installations and sampling; eight samples for VOCs, BNAs, and selected metals
4	Sites 19 & 20 Newfields & Grafton Ditches	o Expanded sediment sampling program	o Localized quantification effort for VOCs, BNAs and selected metals (12 samples)
		o Resampling surface waters	o 2 rounds, 10 samples for VOCs, BNAs, and selected metals.
		o Aquatic biological investigation/receptor analysis	o Based on Stage 2 analytical findings
	Site 9, CRD 1	o Expansion of surface water quality monitoring	o 3 round - 9 samples VOCs to determine site-specific water quality constituents

Notes: VOC = Volatile Organic
BNA = Base Neutral/Acid Extractables
PNA = Polynuclear Aromatics
PCB = Polychlorinated Biphenyls
GC = Gas chromatography

TABLE 6-1 (continued)

SUMMARY OF INVESTIGATION RECOMMENDATIONS

Zone	Site	Recommendations	Level of Effort
5	Site 6, LF-6	o Aerial photo reassessment	o Fracture trace analysis
		o Test pit investigation/soil gas investigation	o Define fill limits and waste characteristics
		o Install additional monitoring wells	o Five multi-level well installations and sam pling; five samples for VOCs, BNAs and selected metals.
		o Expand surface and groundwater sampling protocols	o 40 samples for VOCs and selected metals with 20 of these samples for BNAs.
		o Geophysical Investigation	o Define fill limits and potential migration pathways.
		o Aquatic biological investigation/ receptor analysis.	o Based on Stage 2 analytical findings.
		o Groundwater modeling	o Analytical models for flow and transport, if necessary.

Notes: VOC = Volatile Organic
BNA = Base Neutral/Acid Extractables
PNA = Polynuclear Aromatics
PCB = Polychlorinated Biphenyls
QC = Gas chromatography

TABLE 6-1 (continued)

SUMMARY OF INVESTIGATION RECOMMENDATIONS

Zone	Site	Recommendations	Level of Effort
	Sites 10 & 22 LFTS and Site No. 22	o Air photo reassessment	o Detailed effort to define suspect burial/burn sites.
		o Non-destructive testing	o Detailed GPR/EM survey to define limits of burial sites (including confirmatory test pits).
		o "Expedited Remedial Action" at drum burial site	o Removal of drums and associated contaminated soils, RCRA chemical characterization of 6 samples, and off-site disposal.
		o Expanded test pit/soil boring and sampling program	o Localized quantification effort of 12 samples for VOCs, GC fuels analysis and lead; 6 selected analyses for BNAs and PNAs at Site 22.
		o Resampling of existing monitoring	o 2 Rounds - 6 samples for VOCs and Lead; 3 selected BNAs and PNAs
		o Install additional monitoring wells	o Three multi-level well installations and sampling; 6 samples for VOCs, lead, BNAs and PNAs.
		o Groundwater modeling	o Analytical modeling analysis

Notes: VOC = Volatile Organic
BNA = Base Neutral/Acid Extractables
PNA = Polynuclear Aromatics
PCB = Polychlorinated Biphenyls
QC = Gas chromatography

6.3 SITE-SPECIFIC REMEDIAL INVESTIGATIONS

The abandoned waste TCE tank at Building 244, within the IS/PA, and the buried drums in the LFTS are recommended for "expedited remedial action."

It is recommended that the contents of the tank at Building 244 be removed and placed in suitable containers for analysis prior to disposal and that the tank be excavated and disposed of with the containerized soil and liquid wastes in such a manner so as to comply with applicable state and federal regulations. The soils in the vicinity of the tanks should be sampled and tested for volatile organic contaminants. Soil gas testing should be performed to supplement laboratory test data.

The buried drums at the LFTS should be excavated, placed in suitable "overpack" containers and removed from the site. The contents of the drums and the soils beneath the drums should be sampled and analyzed to fully characterize their contents prior to their removal from the site. The fully characterized and containerized wastes should be transported to an approved waste disposal site capable of accepting the type of wastes characterized.

DATE
FILMED
2 8